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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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The Registered Office and Laboratories of the B.C.I.R.A. are at:—
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Telephone: Central 1885. Telegrams: CIRA.
The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk *(Telephone 332).*

Forthcoming Events.

NOVEMBER 26.

Institute of Metals (Birmingham Local Section):—Ordinary meeting at Birmingham. "The Modern Development of the Steam Locomotive." Paper by G. W. Woolliscroft, O.B.E.

Institute of British Foundrymen.

NOVEMBER 23.

East Midlands Branch:—Ordinary meeting at Loughborough. "Work in a Jobbing Foundry: Pipes, Rope Pulleys, Hydraulic Cylinders, etc.," Paper by A. Sutcliffe.

Newcastle and District Branch:—Visit to Messrs. Sir W. G. Armstrong, Whitworth & Company (Engineers), Limited. Lecture in the evening on "Hidden Facts in Oil-Sand Practice," by F. Hudson.

Lancashire Branch (Junior Section):—Ordinary meeting at Manchester. Lecture by A. Phillips.

How Does Metal Solidify?

It may not unreasonably be said that the chief preoccupation of the foundry metallurgist is the solidification of molten metal in the mould, and few people realise how basic is an adequate understanding of the problems that arise from this process in all metallurgical work, since nearly every metal in common use must pass through it at some stage in its history. A very large number of the problems that subsequently arise do in fact originate during the solidification process. Practical men have of necessity evolved their own methods of meeting these various problems. Such methods differ from shop to shop, according to the experience of the individuals concerned, and their success likewise differs from shop to shop. Where foundrymen are concerned, it will be admitted that in the matter of shrinkage and contraction alone a very great deal of work has yet to be done before we can produce cast iron, steel, or non-ferrous metals with any degree of real certainty or confidence.

The problems that arise in connection with the solidification process are so many that it is not possible to enumerate them here in full, but a few examples will serve to recall to every practical man the kindred questions that concern him most closely. What, for example, is the precise effect of the temperature reached during the smelting process, and of the temperature of remelting and pouring on the properties of various types of castings? What are the differences introduced by melting hot and cooling to a lower temperature before pouring, and melting and pouring at the lower temperature? What is the precise effect of running quickly or slowly? What relationship is there between the properties of the metal and gases? What is the precise effect of superheating? What considerations govern whether crystal size shall be large or small? What exactly governs the change-over from columnar crystallisation at the edge of the mould to spontaneously-formed crystals in the interior?

It is evident that this problem—or rather, this group of problems—cannot be worked out in ordinary commercial undertakings. It is, too, a problem in the solution of which large expenditure is likely to be involved, yet we feel that it will have to be tackled sooner or later if the industry is to avoid the major wastes arising from defective castings, and if we are to get the best properties from cast structures. Taught by the lessons derived from previous research, the steel industry has made a bold effort to tackle the problem in its Heterogeneity Committee. There have also been tentative efforts to deal with it in non-ferrous quarters. With cast iron, however, the nature of the metal introduces further complications, which, while they render the solution of the problem all the more necessary, have hitherto succeeded in preventing any determined approach to it.

Developing Alloy Cast Irons.

It is now definitely established that nickel and nickel-chrome cast iron have created for themselves a distinct sphere in ferrous foundry practice. The fact that foundries are registering trade marks for their particular brands of alloy cast iron is concrete evidence of its commercial acceptation. High-silicon cast iron, too, has long been accepted an acid-resisting alloy, but up to now no ameliorative influence of a high manganese percentage has been broadcast. Some of the more expensive metallic additions are known to bestow useful industrial properties, but at a non-competitive cost. Aluminium as an alloying material seems to be rather uninteresting, though it might with profit be given another chance, using superheated cast iron as a base.

In any reasoned consideration of alloyed cast iron, or indeed for any metallic alloy, too much stress should not be given to the tensile or other common strength properties. The chief virtue of cast iron is its "running" properties associated with machinability. If one can maintain these and induce a third attribute—may be weldability; "non-growth"; strength under compression, tensile, torsion, shock, etc., or resistance to corrosion or erosion, and accomplish this at a reasonable price, then a discovery of real worth will have been made. In any research made to bring about any of these objects, cognisance should be taken of the price characteristics of competitive material already available, such as steel and non-ferrous alloys. We are of opinion that the time is now ripe for experiments to be made on "tertiary" alloys, regarding cast iron as one entity. Some recent work by Ballay on nickel-chrome-copper alloys is particularly interesting; he has shown that under laboratory conditions they are worthy of study from the aspects of corrosion resistance, rustlessness and stability under elevated temperature conditions.

Fairly wide mechanical properties are shown, depending, of course, on the silicon, nickel and chromium contents. These alloys are by no means comparable with austenitic "stainless" and alloys filling that category for resisting corrosion, or with the various nickel chrome alloys for heat resisting properties, but because of the cheapness, casting and machining properties they are capable of economically replacing brasses and bronzes in certain cases. They are infinitely superior to all machinable grey irons for resisting corrosion and oxidation which have so far been used. Surely, on this showing, there are good reasons for further research work.

XUM

I.B.F. Branch-Presidents—No. 1.

MIDDLESBROUGH BRANCH.

Mr. Noel D. Ridsdale is the younger son of Mr. Charles Henry Ridsdale, F.I.C., etc. His early experience in iron and steel works began at the North Eastern Steel Company, Limited, Middlesbrough, where he was employed for several years in their steel works and blast-furnace and coke-oven laboratories, and became a senior metallurgical chemist. During this period he obtained the Honours Certificate of the London, City and Guilds Institute for iron and steel manufacture, and later on became for several years Evening Class Lecturer on this subject and instructor in Practical Metallurgy at Middlesbrough.

In 1912 he commenced and carried on the firm of Messrs. Ridsdale & Company, of which, though joined later by his father, he still carries on the active management.

Nearly four years ago, Mr. Ridsdale's contact with some of the foundries in the Cleveland district impressed him with the need of better facilities for the technical training of foundrymen and for their association to mutually discuss their problems. This caused him, together with Mr. S. V. Toy, to be instrumental in forming in 1926 the Middlesbrough Branch of the I.B.F., of which he became the secretary from the commencement and remained so until he was elected President for the ensuing year, owing to both the Vice-Presidents being unable to accept the office.

Mr. Noel D. Ridsdale.

Mr. Ridsdale has been particularly interested in moulding sands and melting practice, and in 1928 was awarded the Institute of British Foundrymen's Diploma for a Paper on "Practical Moulding Sand Control"; whilst a Paper on "Fuel Economy in the Cupola" was given to the Middlesbrough Branch during last session.

He is intimately associated with the development of the "Analoid" system of analysis and the British Chemical Standards movement. In addition to being a member of the I.B.F., Mr. Ridsdale is an associate member of the British Cast Iron Research Association, member of the Iron and Steel Institute, the Cleveland Institution of Engineers, Fellow of the Chemical Society, member of the British Association of Chemists, and the Society of Chemical Industry.

Institute of Metals—Sectional Chairmen.

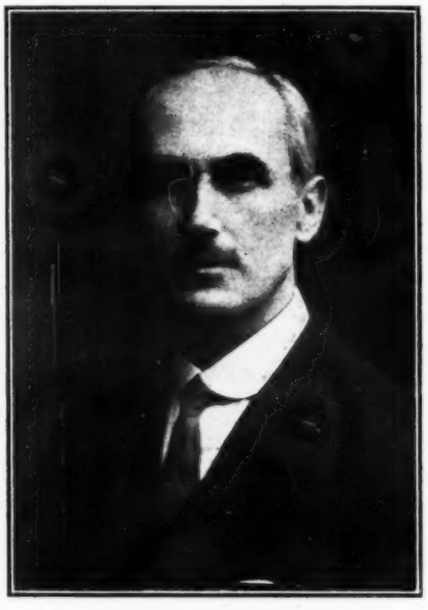
No. 1.—BIRMINGHAM SECTION.

Dr. O. F. Hudson, A.R.S.C., has been Chairman of Birmingham Section of the Institute of Metals since 1928, whilst previous to this he was Honorary Secretary of the same Section from 1914 to 1916 and Chairman of the London Section in 1921.

He received his training at the Royal College of Science and at the Royal School of Mines, London, from 1897 to 1901, and carried out post-graduate work as research assistant in the laboratory of the Royal Mint, London, under the late Sir William Roberts-Austen.

From 1902 to 1916 he was Lecturer in Metallurgy at the University of Birmingham, and spent two years with Dr. G. D. Bengough on a corrosion research for the Corrosion Research Committee of the Institute of Metals.

Dr. Hudson was metallurgist to the Admiralty Engineering Laboratory, a section of the Department of the Engineer-in-Chief of the Navy, from 1918 to 1924, and since then has been Superintendent of Research of the British Non-Ferrous Metals Research Association.



Dr. O. F. Hudson.

Dr. Hudson is also a member of the Iron and Steel Institute, the Society of Chemical Industry, the Faraday Society and the Institution of Mining and Metallurgy.

Industrial Psychology.

"This city is the home of economics, and although it is an old dog there is life in it yet; enough life to bring it to the forefront." Thus said Sir Josiah Stamp, G.B.E., president of the L.M.S. Railway Company, in an address on Industrial Psychology at the Glasgow Chamber of Commerce recently. The meeting had been called to consider the establishment of a branch of the National Institute of Industrial Psychology in Scotland. Sir Josiah, in seconding the resolution to found a branch in Scotland, dealt with the effect of psychology on industry, and said that at the present time there was a tendency to speed up, but it was no use speeding up without proper lubrication and fittings: it led nowhere. The Institute made speeding possible by working in the right key. It is a well-known fact, said Sir Josiah, that better production is not obtained by long hours.

Random Shots.

All the way from America comes a letter in my post-bag this week, to point out in the nicest possible way a somewhat ambiguous remark that I perpetrated a few weeks since all about the relation between ferrous and non-ferrous interests. I was commenting on the National Metals Exposition held in Cleveland, as a matter of fact, and expressed my interest in the participation of the American Foundrymen's Association, "in spite of its primarily non-ferrous character." The last remark applied to the Exposition, not to the A.F.A., but re-reading the comment in question I realised that it did sound more than a little misleading, so I am offering this public explanation. Like most other founders' associations, the A.F.A. caters for all classes of founders. But like them, too, it has a certain preponderance of the ferrous interest.

* * *

At the time I went on to remark that this whole question of ferrous and non-ferrous interests and their relationships was worthy of comment elsewhere, but no one seems to have taken the hint. I was fresh then from my German experiences, and the surprise of discovering that over there "metallurgie" definitely means non-ferrous metallurgy! Rather a blow that to some of our friends who refuse to recognise any distinction between the two! Of course, in many respects they are right. From the scientific point of view, no doubt, there is a great deal to be said for such an amalgamation of interests, and, after all, it already exists to a considerable extent. But my own view—a view that is not unsupported in foundry circles, I know—is that when division is necessary it should be division on a basis of function rather than on a basis of material. Especially is this the case in foundry matters. Anything that emphasises the significance of the foundry process and its attendant problems rather than the significance of a particular material is undoubtedly in the right direction.

* * *

I have been thinking over the phenomenon, well-known to founders, of the increase of weight that you find if you compare the new sand coming into a foundry and the old sand taken away. If, as seems not improbable, the increase is due to shot and other additions that find their way into the sand during its lifetime in the foundry, isn't there an admirable opportunity for any young hopeful who wants something to investigate? What proportion of the increase of weight is in fact due to such additions, for instance, and what are the prospects for its recovery?

* * *

From time to time rumours reach me of a growing movement for Brighter Foundries. Being an ardent advocate of anything in the way of brightening—whether its object be the English Sunday, London, our seaside resorts, or our wireless programmes, I have naturally taken a great interest in the matter. But hitherto it has been wrapped about with the greatest secrecy, and all that I have been able to ascertain is that such a movement does exist and that it awards an annual prize for the best suggestion for Brightening the Foundry. I was lucky enough to obtain the following details of this year's prize suggestion. "For some years," writes the competitor, who goes by the pseudonym of "Old Hand," "we have provided liquid refreshment in the foundry daily at 11 and 4. It is served by young ladies wearing a distinctive uniform, this uniform being changed every two months. The latest uniform issued took for its inspiration the costume worn by the chorus in a recent successful 'Talkie' film."

Marksman.

Tests for Cast Iron.

Which kind of test for cast iron appeals most to the foundryman? That of the chemist, the metallurgist or the engineer? In an interesting Paper on "Tests for Cast Iron," Mr. J. G. Pearce, M.Sc., M.I.E.E., dealt with the advantages and disadvantages of these three forms of tests when he addressed the Middlesbrough Branch of the Institute of British Foundrymen, at the Cleveland Technical Institute, recently. The President, Mr. N. D. Ridsdale, occupied the chair.

Mr. Pearce said that it was a universal experience that when people bought anything they usually required some sort of guarantee of quality, and cast iron was no exception. In asking his audience to consider the question of tests as a guarantee of quality, he said that if a founder were asked what kind of test would satisfy him as to quality of cast iron, he would probably reply in favour of some form of chill test. He feels that chemical analysis is rather a tedious method of examination, the result of which take some time to obtain, and he is also aware of anomalies. He feels that mechanical tests are unsatisfactory when an engineer calls for one bar size for all size of castings, and when the engineer calls for a test-bar that means a bad casting the founder feels that there must be something wrong with the system.

We are forced back to some practical test which is easy to make in the foundry, and this, Mr. Pearce considered, must take the form of a chill and break test. The chill test was, in a sense, a fracture test, and it was sound, because strength (which was the thing buyers want to test) depended on structure, which could be estimated in part by fracture.

It was logical, because many castings which it would be foolish to judge by mechanical tests (such as chilled rolls) could be very well judged by a chill test. The test, of course, was not new, and Keep's test was still used in many grey-iron foundries. In chill-casting foundries it was the rule rather than the exception.

The question of a standard chill test was very difficult to solve, and the speaker for one did not think one could arrive at a standard test. We had not even a standard size for test pieces or yet a standard shape.

Regarding the fracture in cast iron, he believed that fracture was a very valuable piece of information to the foundryman, and it would be of interest to know what different founders meant by "open-grained" or "close-grain," by "fine" or "coarse," and whether colour played any part in it. It would be interesting to know how far was openness or closeness a matter of graphite size, or of graphite quantity. Could one have an open but strong iron? Or a close but weak iron? What was the connection, if any, between grain size or phosphide and carbide distribution? Could an experienced man take size fully into account?

The chill test was valuable, because all the elements of cast iron had their effect on whitening or greying the structure, and the founder was concerned, not with the individual effects, but with the collective effects. This the chill test gave. Unfortunately, the engineer, chemist and the metallurgist could not read fractures and would have none of it. At the same time it was a test he would recommend for foundry control.

Dealing next with the chemical test, Mr. Pearce said the chemist would naturally suggest analysis as a test for cast iron. He would say it was most important and valuable, because it gives the actual constitution of the metal. Conventional analysis did not include anything outside T.C., Si, Mn, S and P. It excluded other elements, rare elements, gases, because their quantities were too small and procedure became lengthy and expensive. We were all aware of the effect of manganese on iron.

Continuing, Mr. Pearce said that experiments had been made in this connection, and it had been borne in mind that one could get from the same cast irons of different qualities, and that irons of the same chemical compositions could have varying structures. Extremes were not met in foundries, but differences were, and there were many theories for such variations.

Coming to the metallurgist's point of view, he said that this class of analyser would say that the only way to ascertain the properties of metal was by an actual study of the properties of the iron. Knowing that structure was really the ultimate factor, the metallurgist would also urge the direct study of structure.

He would be right in so far as this took into account all the factors at work—that affected strength, composition, rate of cooling and melting conditions—but it was inadequate, because it did not show all the elements—silicon, manganese, nickel—which go into solution. It was inadequate, because it would involve too much examination; and it was difficult, because few people had the technique of polishing and etching. We could estimate analysis from microstructure, though microstructure was not likely to become a standard test, despite the fact that they were making their appearance in patent specifications.

In his final conclusions, Mr. Pearce said that, as a buyer, the engineer wanted a commercial and somewhat rough and ready test. He designed on mechanical strength, he was accustomed to tensiles in steel, and so he preferred tensile tests. The transverse test was, however, the popular foundry analysis.

Hard Solders for Copper.*

Hard soldering of copper has always presented difficulties. Comparatively good soldering results can be obtained with molten bronzes that contain copper with zinc or tin, but the soldering operation with these molten materials is injurious to the health of the men employed, owing to the toxic action of the metallic vapours given off. Pure copper is not suitable for soldering metal because molten copper readily oxidises. The oxide formed becomes dissolved in the molten metal, with resulting reduction in strength and toughness. For this reason phosphorus has been added to the copper as a de-oxidising material, and its use gives a stronger and tougher joint.

Recently silicon-cobalt-copper alloys have been used for the hard soldering of copper. The soldered seam obtained by the use of this alloy is sufficiently strong, but has only a comparatively small extension. A recently-discovered soldering alloy which avoids the disadvantages of those hitherto used is a copper-silicon-manganese alloy, which not only prevents the oxidation of copper, but considerably increases the strength and the extensibility of the joint. The first experiments with the copper-silicon-alloy solder showed that for certain purposes the addition of manganese was desirable. The manganese was found greatly to increase the strength and also to have a favourable influence on the copper, especially when it contained some oxide. Experiments with the copper-silicon-manganese alloy as solder have proved that 0.80 per cent. silicon and up to 1 per cent. of manganese in the copper produces a soldering alloy which gives the most satisfactory results. An alloy with 0.60 per cent. silicon and 0.80 per cent. manganese is, however, generally employed, as it is more easily worked. In no case must the silicon content be less than 0.3 and the manganese content be less than 0.5 per cent. However, larger quantities than those given above can be used, for example, in cases where it is necessary to have a solder whose colour is the same as the ground metal, and when particularly high strength and toughness are not essential.

These alloys are especially suitable for use in soldering copper containing oxide, but they are also quite suitable for soldering de-oxidised copper and copper alloys containing zinc or tin in small quantities. Independent of whether the ground metal contains oxide or not, the soldering alloys of the above compositions have high strength and toughness, and, as hard solders, are easily worked.

If a hard soldering copper alloy containing phosphorus is employed, a comparatively good result is obtained if a little silver is added, but this does not effect the removal of any sulphur contained in the copper. In soldering copper objects, such as boiler parts, heating coils, etc., which come in contact with fire gases, the copper invariably contains some sulphur. The removal of this sulphur in soldering is just as desirable as the removal of oxygen, as the presence of sulphur in the soldered part always tends to diminish the strength. Experiments have shown that with a suitable composition of soldering alloy it is possible to remove completely both sulphur and oxygen, and this is effected by the addition of a small quantity of lithium to the solder.

The action of such a solder is due to the fact that lithium in the molten solder combines with any oxygen and sulphur present in the metal at the soldering point, and the soldered portion is completely freed of these injurious constituents, thus giving high strength in the soldered seam. The lithium serves also to increase the fluidity of the soldering alloy, even more so than does the addition of phosphorus. This high fluidity assists in the taking up by the flux of the lithium oxide and lithium sulphide formed. Quite small additions of lithium suffice to obtain the desired results. It is best to add from 0.3 to 0.01 per cent. so that it becomes completely oxidised and expelled from the solder, leaving the soldered seam quite free of lithium. Besides lithium, a soldering alloy may contain small quantities of silver, which, however, remains in the soldered joint and improves the physical properties of the seam.

* Abstracted from "Die Metallborse," September 14, 1929, page 2052.

Man and Industry.

The structure of man in relation to industry was the subject of a public lecture under the auspices of the London Lectureship in Engineering Production, delivered in the University of Glasgow by Professor E. P. Cathcart, Regius Professor of Physiology. After dealing in broad outline with the three main systems in a human being, viz., the respiratory, the circulatory and the neuro-muscular, the lecturer stated that in order that a man should be able to perform the maximum amount of work those three systems required to be in perfect order, but that was not the end of the story. It was possible for advancement to be hindered by a workman becoming too perfect, and if rationalisation was brought about there would be much complaining in that respect. A workman who became so perfect at using a particular machine that his actions were almost involuntary would find very great difficulty in adapting himself to a new and perhaps better machine, with the result that neither he nor the machine would be so efficient. The man would grumble at the machine and say it was bad, and it would not be a case of a bad workman finding fault with his tools. He simply could not help it. The emotional responses of a man had to be taken into consideration, and it was the psychological factor rather than the physical factor that determined what a man could do.

D

Patterns in the Steel Foundry.*

By G. E. Wells.

The steel founder is the Cinderella of the engineering trades. Everyone else knows how to make a steel casting; the job is so simple, and the most elementary part of it is the pattern. That is why the founder is so rarely consulted, with the result that much trouble and expense are caused.

The attitude of mind is that which caused the engineer to put down his own iron foundry in so many cases. He argued that, being an engineer, he could produce perfect castings and also eliminate all delay, and that is why there are so many small iron foundries in existence to-day, most of them working short time and nearly all of them inefficient.

Having dealt to his own satisfaction with the iron-foundry question, the engineer is now quite confident that he knows all about pattern-making, and, working in collusion with him, is generally to be found a buyer who knows all about buying. An inquiry is issued for twenty castings weighing one ton each. The two most favourable quotations received are from firms A and B, who offer respectively 28s. per cwt. for the castings and £30 for the pattern, and 30s. per cwt. and £20 for the pattern. Obviously, the former offer is the more advantageous, but why, demands the buyer, does A want £30 for a pattern which B will make for £20?

Both firms are of good standing and reputation. The engineer is indifferent, as it is the casting he wants, and he is content that the steel founder who gets the order shall decide on the way the pattern is made. Herein he makes a mistake, as it is more than probable that the more expensive pattern will produce the better casting, more uniform, more accurate to dimension, and therefore less expensive to machine. The £20 pattern will most likely be of the skeleton or model form, easily damaged in the foundry and designed for moulding by hand. The higher-priced article will be designed for machine moulding, a stripping plate will have been provided for, and the pattern will be in as good condition at the end of the order as it was at the beginning.

This is a case where the engineer should use his knowledge, insisting on the offer made by A being accepted. However, more often than not he is nonchalant, and the buyer proceeds to deal with the job in his own way. Why should one firm want £30 for a pattern which another firm of repute is prepared to supply for £20, says he, and writes to A accordingly. A does not know that if the order is placed with B the castings will cost £40 more, against a saving of £10 on the pattern. Quite naturally, the buyer refuses to disclose to A the price which B has quoted for the castings, and it is only when A, anxious for the order, has agreed to split the difference, that he realises his competitor must have quoted more for the castings than he did. Even then he has no actual figures to go on, and he can only make the best of a bad job.

There is another type of pattern which causes much trouble to the founder, and that is the one which is altered time and time again owing to a change in design. Such a pattern is generally a cause of real trouble, as it produces a mould which requires a large amount of "mending up," an operation both expensive and inaccurate.

In a modern steel foundry costs of production are carefully estimated before a price is submitted. In the writer's own plant the estimating staff, on examination of a drawing, can state the cost of moulding to the smallest possible degree of error, but calculations are naturally based on the assumption that the pattern will be well made and in good condition. When the latter comes to hand, however, it is quickly appreciated that the estimate will be very much exceeded, it being necessary substantially to increase the moulder's piece-work price or do him an injustice. The pattern is old and patched up; it is designed to leave its own cores instead of being printed and provided with coreboxes; it probably breaks when an attempt is made to withdraw it from the mould; and the condition of the latter may be imagined.

The founder has no redress, because if he complains, he will be told that the price he quoted was used in the making up of the estimate for the complete machine, the maker of which has actually taken the order at a loss to keep his shops going. The buyer of the machine will on no account pay any more, and therefore there is nothing for the founder. Why this should be so is difficult to understand, but it is a curious *coincidence* that the engineer strongest and most persistent in his condemnation of the steel founder, is generally the one who supplies the worst patterns.

Only a few hours ago, the writer's attention was called to a typical example of the pattern under review. This one was built up of very old wood with a certain amount of new, paint or varnish were conspicuous by their absence and no filleting was used, so that the moulder had to cut off all corners and form the necessary radii in the mould. In addition, the pattern was made like a model necessitating the ironing of cods (*i.e.*, the reinforcing of hanging portions of sand in the mould by means of irons) so that they may be picked up in the top part, and several drawbacks are necessary.

When a casting produced from such a pattern is received by the purchaser, he writes to the founder complaining of radii varying in size or absent altogether, roughness of skin, varying machining allowances, and general malformation, and as a statement of fact, what he says is correct. On the other hand, it was only to be expected, yet the founder must accept the blame. True, on seeing the pattern he could have refused to proceed, but in that case it is hardly necessary to state what would happen, especially in times like the present, when every steel-casting maker is wanting work.

The other type of pattern which causes much trouble to the founder is the one made by the professional pattern-maker, who has an extraordinary fondness for glue instead of screws. The patterns themselves generally look very nice, as all sharp corners are filleted and a coat of good paint is applied. However, when the pattern has been in the damp sand a few times it comes adrift, and delay, disorganisation and expense are caused by the necessity of sending it in for repair.

To sum up, a good pattern pays in the long run, and to such an extent is this statement true that in the Edgar Allen foundry it often happens that a customer's pattern is never used at all, as one made on up-to-date lines will give cheaper and speedier production whilst at the same time giving the buyer a sounder and more accurate casting.

* Extracted from the "Edgar Allen News," November, 1929.

Applications for Trade Marks.

The following list of applications to register trade marks is taken from the "Trade Marks Journal":—

"Vallium."—Steel and iron wire. British Ropes, Limited, 32, Cavendish Square, London, W.1.

"Hiperbil."—Metals. Joseph Sankey & Sons, Limited, Albert Street, Bilston, Staffs.

"Gomak." — A die-casting metallic alloy. Brandeis, Goldschmidt & Company, 9, King William Street, London, E.C.4.

"Combustic."—Steel alloys. Coopers Mechanical Joints, Limited, Manor Works, Lower Kennington Lane, London, S.E.11.

"Jackdaw."—Iron and steel. J. H. Vavasseur & Company, Limited, Ceylon House, America Square, London, E.C.3.

Coal-Dust in Moulding Sands.

By I. Clayton.

Though coal-dust is used in the preparation of facing sands for making castings in green sand, the reason for its use has never been satisfactorily explained. Some foundrymen insist that coal-dust is useless, and that the blue skin exists only in the minds of the coal-dust salesmen. As a moulder, the author carried out a test by making 12 castings weighing about 1 cwt. each. Six of these were made with a facing sand containing 1 part of coal-dust, 5 parts of red sand and 15 parts of floor sand. The red sand was of the weak type, which owes its bond chief to iron oxide. The second set of six castings were made with a similar mixture of sand containing no coal-dust, except that introduced by the floor sand. The moulds were made in the ordinary way, and blacking was well rubbed into the surface. They were all cast with hot metal. When the castings were removed from the sand and fettled, there was no apparent difference in the two sets of castings. Before fettling, however, it was noticeable that the sand stripped more easily from the castings moulded with material containing coal-dust, whereas those made without coal-dust required a considerable attention, both with the wire-brush and with carborundum block, to remove the adhering sand. The coal-dust, then, apparently in some manner causes the sand to strip easily from the castings.

A Theoretical Explanation.

A consideration of the chemical and physical properties of moulding sand emphasises these facts. Moulding sand is composed chiefly of silica, which is highly refractory, together with a certain amount of alumina, which is also fairly refractory; there is also in most moulding sands a small percentage of iron oxide, which, with the alumina, supplies the bond necessary for the working of the sand. The iron oxide has the property of lowering slightly the refractoriness of the sand. There exists, then, a mould constructed of a material not too highly refractory in character, which under the heat from the molten metal just begins to soften at the surface. In the absence of an entity to prevent it, the grains at the surface of the mould fuse at their points of contact. This constituted the crust which was difficult to remove on the castings made without coal-dust. When coal-dust is present in the sand the grains are kept isolated during the critical period by the products of the distillation of coal-dust being deposited on and circulating about the sand grains. Thus, although the softening takes place, the grains do not fuse together because the products of the distillation of coal-dust prevent actual contact between the softening grains of sand.

When the crust of fused sand mentioned before occurs in an aggravated form on the face of a casting, it is often quite erroneously stated by men of experience that the iron has eaten in. This phenomenon occurs on very heavy green-sand castings, or at the bottom of exceptionally deep castings where high pressures obtain. The coal-dust cannot, under these conditions, exert its protective action, because the gases, tar and carbon-black have been driven completely away from the surface of the mould long before the temperature of the casting has fallen below the softening temperature of the sand. When this fusing on occurs, the foundryman must either obtain a more refractory sand, or, as is more commonly done, the job must be made in dry sand. The stripping of the sand from a dry-sand casting is assured because of the refractory nature of the thick coat of blacking which is given to the moulds, this renders the presence of coal-dust unnecessary.

Cupola Refractories.*

By Colin Presswood, B.A., F.G.S.†

The importance of this subject is clearly seen in the proportion of production cost of cupola metal which is due to the lining materials. That its importance is widely recognised is shown by the large number of Papers appearing in technical literature. The theme is perhaps a little hackneyed but by no means worn out, and apology for reviving it is perhaps unnecessary, as it is certainly true that large numbers of corporations and individuals who use these materials do so without full knowledge of their properties and limitations. It is now well recognised that careful choice and use of refractory materials in all kinds of circumstances is quickly reflected in production cost accounts, and there are many examples of savings effected on the one hand by the use of a new and more suitable material, and on the other hand by the more careful use of materials already adopted.

Cost Reflected in Finished Materials.

The contribution of refractory linings to the total cost of the cupola operation can only be truly estimated on a basis of the cost per ton of metal melted, and one might go further and say per ton of good castings sold (or stocked!), since cupola linings do affect the condition of the metal and therefore the results obtained from the mound. True cost is not first cost, but includes this item. In considering true cost it is necessary to consider the labour spent in patching or building, the loss of production, the amount of coke used in melting the lining and the loss of metal by way of the slag. In exceptional cases repairs may be so extensive that an extra furnace is necessary as a stand-by, and capital charges are increased. Reference is made to this point later, as this may well be one method of securing better service from linings. In which case it may be more than justified.

Figures as to true cost are rarely mentioned, though one hopes they are taken. If there were more free exchange of such figures both suppliers and users would benefit, since this is the ideal basis of buying and selling. Like many other ideals, it is by no means easy to carry out.

Meat and Poison.

The principal reason for this lies, perhaps, in the effect of conditions under which the materials are used. It is well known that the same material, used at different works on apparently the same work, gives vastly different results. No material is universally popular, and in this may lie a veritable gold mine of information on the subject we have under consideration. These strange differences exist even when the cupolas are of same size, charged in the same way with the same materials, the same percentages of fluxes, and the same blast, with similar output of the same class of metal.

Perhaps this is so rigid a condition that it rules out many apparent discrepancies, but there still remain a few. These may be accounted for in part by the "human element" and personal prejudice on the part of the user, which are important factors. There is good reason to believe that even such a narrowing-down of possible factors may still leave discrepancies.

One concludes, therefore, from this, as from other spheres, that the science of refractories in relation to their use in metallurgy is by no means "exact." One cannot yet say, with complete confidence, that a material of such-and-such chemical composition and physical properties will give certain results. Refractory-material manufacturers are accustomed to the most queer contradictions. The author has seen excellent technical reports on material which fails in many cases if not in all.

This is not to decry attempts at applying technical knowledge and research to the problem of cupola linings, for there is every reason to encourage this, and clear evidence that practice is being explained on technical lines. In the present state of knowledge it is advisable to accept purely scientific data and deductions with care—an attitude taken up by most of our leading technical men. Discrepancies must not, however, be made the basis of wholesale condemnation of scientific research in this or any other department of foundry practice.

The first step in investigating cupola linings is to consider just what are the conditions in the furnace which tend to shorten the life of the lining and how they operate. This is not well known. There are cases where better results have been obtained with a new material than with the old and the material has received the credit, whereas some, if not all, of the credit should go to a change in practice, whether in blast pressure, tuyere area and disposition, or other item. Conversely, materials are often held responsible when practice is at fault, so that results should not always be "credited" (or is it "debited"?) to the lining material regardless of changes in practice.

Accepting this, there are still wide differences in materials offered as cupola linings, and within the limits mentioned above these can be detected by scientific investigation, thereby avoiding the trouble and expense of a practical trial. Cupola linings are subjected to: (1) High temperature; (2) rapidly changing temperature; (3) fluxes such as lime, fluorspar and silica, and (4) mechanical wear and abrasion.

Temperature Conditions.

Estimates of the temperature on the face of the cupola lining vary somewhat and are difficult to measure accurately. It is safe to say that the temperature is well above the softening-point of most refractories as indicated, say, by an under-load refractoriness test and may be higher than the cone test figure. In some cupolas the lining may depend for its life on the cooling through the shell, and in special cases water-cooling (which has assisted greatly in boiler-furnace walls) may be beneficial and almost necessary. The following remarks will apply principally to melting zone, where the most serious trouble occurs. The upper part, where mechanical strength is the most important destructive agent, can more easily be dealt with, but it is not always realised that two or three different materials may be used with advantage in the various parts of the lining. It is not to be expected that one material will meet all conditions. This applies to brick, and especially to rammed linings.

Temperature Fluctuations.

That temperatures change very rapidly in most cupolas will not be disputed, and herein lies the principal cause of destruction of linings. In greater or less degree all refractory materials change in volume on heating and are strained so far by rapid heating that they crack. The effect is known as "spallin," which is responsible for the greater part of lining destruction. Other factors have their effect, but this has the greatest.

Rapid temperature change has another effect when applied to moist materials used in patching and ramming. The heat is really called upon, in the first place, to dry the clay which nearly all cupola materials contain. It is general knowledge that clay shrinks on drying, and any brick manufacturer realises that drying of shapes, before they are burnt, is a most important feature and one that may give great trouble. Even after the clay is dried it still has a burning shrinkage which may be serious. If clay mixtures need careful drying in manufacture of bricks, it is reasonable to specify the same care with reference to the first heating and drying of patches containing wet, raw clay. This point is amplified later.

Influence of Fluxes.

Fluxes certainly have their effect in attacking linings, as also has slag, but since the very nature of cupola melting is vastly different from melting in a hearth furnace where metal and slag are continuously in contact with the lining it is interesting to consider in exactly what way the metal and slag find their way on to the lining if these agents be considered very seriously destructive. Does the blast force a spray of liquid metal and slag on to the face of the lining? If so, the effect would be very serious. If, on the other hand, the blast is not strong enough to do this, the part played by these agents may not be so important as sometimes supposed. Is there a continuous stream, or thin film, of metal and slag flowing downwards over the face of the lining?

The postulation of silica as a flux may seem strange, but is explained as depending on the type of lining. If a basic lining were used, then silica would be a flux, just as lime is a flux for a siliceous lining. The suggestion has been made that in a cupola the fluxing agents may be acid (silica from pig) or basic (lime added as a flux) and that as both types operate either separately or together the best type of lining would be neutral. This is a point for debate, as the evidence is by no means certain.

Neutral Linings.

Neutral linings are not generally used except in so far as fireclay can be classed as chemically neutral when it contains upwards of 40 per cent. alumina. There is then no "free" silica (theoretically!). This may account for very successful results obtained with the "Scotch" type of lining in some works, and there is some evidence that a fairly aluminous rammed lining gives good results as distinct from the more common siliceous material.

Experiments with neutral linings which the author has seen made are, thus far, inconclusive, and strangely contradictory, though it is felt that the trouble is largely one of spalling, since the material in question is highly slag-resistant and proves in test to be more resistant to cupola slag than firebrick material. It is doubtful, however, whether the effect of slag in a cupola is identical with that in a test in which the slag is placed on the test-piece—which is one reason for inquiry into the actual mechanism of slag-action in a cupola. Again, the slag delivered by the cupola is the result of union of lining and actual fluxes, whether these are added or are present in the metal charge. So that a sample of cupola slag does not actually represent the material which eats away the lining but rather the resulting "melt" formed by the real flux and the lining.

The sand-coating of pig-iron has been mentioned as evidence that "acid" conditions prevail. One cannot deny that at times a highly siliceous melt may be forced on the lining, but, preferably, one should look at this sand-coating in another way, namely, that more lime has to be added and that therefore greater fluxing action is exerted. This is a point for discussion. It is certainly true that with the type of lining commonly used the lime exerts far more harmful action than the silica.

It is not definitely proved that a neutral lining is best theoretically, and there are certainly good results obtained from siliceous linings and patches, whether bricked or rammed. Even "straight" or lime-bonded silica bricks are used in some works with satisfactory results, though in such cases, personally investigated, it is the

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practice to work continuously until the lining is so thin that the shell becomes hot. This is probably convenient practice and serves to reduce temperature fluctuations which would be fatal to this class of brick, known for its large and irregular expansion and for the careful heating which is needed in coke ovens and Siemens furnaces in which it is used. The particular silica bricks investigated in this connection are found under other circumstances to have lower expansion than most of the same type. They have therefore greater resistance to temperature changes, which may explain part of their successful use as cupola linings.

Destruction by Abrasion.

Abrasion is certainly of great importance, especially in the upper part of the lining, which is, fortunately, cooler. In the melting zone the metallic charge is very soft, if not actually "running," and may not therefore do much damage. It may be the coke which "tears" the lining (which is soft at the surface) and thrusts on it, owing to the weight overlying. If this factor is important it points to the need for a lining which is not soft at cupola melting-zone temperature, and which possesses good tensile strength at high temperatures, a property depending on the nature of its "bond."

Influence of Furnace Gases.

A factor in the destruction of linings not included in the above list is that of atmosphere. Refractory materials, and especially those containing iron oxides, are peculiarly susceptible to reducing atmospheres and may show much lower refractoriness if tests are made in these conditions, than would be the case when made in completely oxidising conditions.

It is well known that the atmosphere in blast furnaces is reducing, and it seems probable that some such conditions may obtain in cupolas. The flame at charging-door level in ordinary cupolas suggests that it is only here that combustion is being completed, there being air available. In the lower regious, therefore, it is probable that the coke is not completely burnt but only forms carbon monoxide. In the Poumay cupola combustion is certainly incomplete at the melting zone and is completed just above by the admission of extra air in the spirally-arranged tuyeres. Combustion is complete when the ascending gases reach the top of the charge.

Now the effect of reducing atmosphere is twofold. It may reduce ferric oxides present in the lining material to ferrous, which readily flux with silica and therefore seriously lower the refractoriness of the lining. Or when, as in this case, the reducing agent is carbon monoxide, there may also be deposition of carbon in the pores of the brick. This is a catalytic action which depends on temperature. It may only take place in the cooler parts of the lining, say above the melting zone or inside the brick wall near the shell. It is described as "auto-oxidation" of carbon monoxide whereby

$$2\ CO \rightleftharpoons CO_2 + C,$$

the temperature being estimated by various research workers as 500 to 800 deg. C. Oxides of iron act as catalysts. Carbon deposit has a violent disruptive action, and this has certainly been successfully advanced as a prime cause in the destruction of blast-furnace linings. Bricks specially designed to meet these conditions have met with success in use, which probably justifies the theory. One cannot say as to how far this factor is responsible for destruction of cupola linings, but it may be important, if not to the same extent as in the blast furnace.

Following the suggestion that lining material should be selected according to the conditions it has to meet and according to its known properties, one logically reaches the consideration of available materials for use in the melting zone. Brick and rammed lining, and patching materials for daily repair, will be dealt with.

Materials Available.

There are only two broad types of common, and therefore cheap, material (speaking of first cost), namely, silica and fireclay. They give rise to a third type which is a mixture of silica and fireclay and is known as siliceous.

As pure silica is rarely used in this connection we can consider that the two types of lining are siliceous and fireclay. The one extreme will be represented by about 88 per cent. silica and the other by about 40 per cent. alumina and practically no free silica. Between the two extremes there is a wide range of mixtures which are in use in one form or another. The "straight" silica bricks mentioned previously can, for the sake of argument, be called pure silica. The expansion and resultant spalling somewhat limits their use, as explained. It is well to point out, however, that this large and irregular expansion is largely due to the cristobalite present in commercial silica bricks, and that the other form of silica, which it is possible to produce in burnt bricks, has much better expansion characteristics. It is known as tridymite. Now the tendency in manufacture of lime-bonded silica brick is for the silica to form cristobalite, but it is now commercially possible to make tridymite bricks which have given good results in practical tests, though they are by no means established as yet. The author is not aware of their being tried in cupolas, and there may be serious objections to such a trial, but the possibility of producing silica bricks with much lower expansion is worth noting. It is difficult to say whether the same principle as is applied to the brick manufacture could be applied successfully to patching and ramming pastes.

Brick Linings.

Having in mind the chief characteristics of refractory bricks, namely, (*a*) chemical analysis which shows proportion of fluxes, (*b*) refractoriness (cone test and under-load test), (*c*) after-expansion or contraction, (*d*) reversible expansion, (*e*) crushing strength and transverse, (*f*) porosity and (*g*) spalling propensities, it is possible to consider fireclay bricks and siliceous in the light of the above considerations as to the factors to be met in the cupola.

Fireclay Bricks having no Free Silica.—The chemical analysis is a guide to refractoriness and to the presence of any free silica which would exert its effect on the lines mentioned below. It is certainly a useful guide, but secondary to other tests. It relates a material to its "group" in the refractories scheme and one expects it to have the character (broad and general) of that group. It will certainly be an important feature if reducing atmospheres are shown to have any of the effect mentioned previously.

In determining its refractoriness the cone test is certainly important, and should show a figure of 1,700 deg. C. at least for this class. The under-load test is most valuable, especially as it can be coupled with a curve showing expansion. The standard load in this country is 50 lbs. per sq. in., and well above the external load which the bricks have to withstand in use. The test does, however, show much more clearly than the cone test at what temperature the bricks begin to soften. Bricks satisfactory for cupola work will not collapse below 1,450 deg. C. in this test in general.

The tendency of bricks of this class is to contract in manufacture, and this contraction may continue in use. A laboratory test may be used to estimate this tendency, which has obviously serious results, if the after-contraction be greater than 0.5 per cent. in standard test.

In general this class of brick has the advantage of very low reversible expansion, so that stresses in the heated lining are lower than would be the case with large expansion of this type. This has a bearing on spalling. Mechanical strength should characterise all cupola linings and should apply to low and high temperatures. It would appear that cupola linings should be fairly dense so as to resist slag and metal penetration.

Spalling.

Spalling is one of the principal causes of destruction, and it should receive closer attention than in the past. The spalling tendency of a brick is not merely a matter of permanent and reversible expansions, but includes the elasticity of the bond between the particles constituting the greater part of the brick. The bricks under consideration should not spall seriously, but may do so if they are so hard-fired and dense that "glass" is formed in the matrix. On this account there is need for compromise, since hard-firing is necessary to reduce after-shrinkage and density is needed to resist penetration of gases, slag, etc.

Properly-made bricks of this class will show low spalling-tendency and low expansion. They may be regarded as chemically neutral and form, therefore, an admirable lining, a conclusion which is borne out by practice, very good results having been obtained with "Scotch" type of firebricks in cupola linings. In one works, linings falling into this class last from two to four years, though no details as to actual working conditions are available.

Kaolin has been described as "the ideal clay substance," and as kaolin bricks are now being marketed they should be given trial as cupola linings. It is to be noted that many new bricks are of rather unconventional appearance and, in particular, some firebricks which are highly successful in boiler furnaces are very friable and apt to be rejected on appearance. Bricks should certainly not be judged solely on appearance. In this case the friability may go far towards reducing tendency to spall.

Siliceous Bricks.

Under this head comes a wide range of chemical compositions covering nearly all possible mixtures of pure silica and pure fireclay, though this is by no means an accurate description. It is purely a convenient form of classification.

Chemical analysis is a useful guide not only to the proportion of fluxes present in the brick material, but as showing (on calculation) what is the proportion of pure or free silica to clay. It is well known that mixtures of clay with silica are less refractory than either of the pure components and it is well to avoid that proportion which forms the eutectic or most easily fusible mixture. The fine material only is to be considered, as it is only when the constituents are intimately mixed that the lowering of melting point can be followed accurately. Thus the proportion of free silica to clay in the fine-grained matrix which surrounds coarser grains of silica, whether in siliceous bricks or raw-patching materials, is very important and reference is made to this point later.

Refractoriness of properly proportioned mixtures may be very high and well above the temperature of the cupola lining. This class of brick is also capable of carrying the standard load, 50 lbs. per sq. in. up to temperatures well above 1,400 deg. C. The "softening range" is apt to be wide and this may be a useful feature. In "straight" silica bricks and in the "Scotch" type of firebrick the range is shorter and collapse, whilst occurring at higher temperature more sudden.

The permanent volume change may be either an expansion or a contraction in this case, because added to the properties of clay are those of pure silica. In manufacture it generally happens that bricks falling into this class are not burnt at so high a temperature, or for so long, as straight silica bricks. The free silica is not therefore completely inverted or expanded. Completion is effected in use or in the after-expansion test. Good bricks of this class will, however, show very small permanent volume changes, of the order of 0.5 to 1 per cent. measured as linear change. If, however, the change is greater, spalling may result.

The reversible expansion is very low in many siliceous bricks, and is, moreover, regular and

even. Such bricks may, however, show clearly the expansion characteristics of silica, whether inverted or not. A familiar, though none too accurate explanation of the low expansion of this class of brick and mixture is that the contraction of fireclay offsets the natural expansion of the silica. This explanation may hold good if the two volume changes take place at the same temperature. Otherwise, the mixture would show most irregular volume change.

The mechanical strength may be excellent, though those bricks of this type which are made from naturally occurring sandy clays are rather friable. They do, however, yield excellent results in some circumstances, which shows that cold mechanical strength is not of prime importance.

The "sandy" type of siliceous brick is not widely used as a cupola lining, whereas raw material of similar type finds wide use in ramming and patching. So-called "ganister" or "semi-silica" bricks, made by mixing siliceous rocks and fireclays, are widely used, as also are naturally siliceous fireclays.

Density of siliceous bricks is quite adequate for cupola conditions. These bricks may be so blended and treated in manufacture as to possess very low spalling tendencies. Whether "natural" or artificial mixtures, the proportion of free silica to clay must fall within safe limits and the heat-treatment must be such as will not produce a "glass" sensitive to temperature changes in the matrix of the brick.

What might be classed as "ordinary" fireclays contain always some free silica, and these form perhaps the most widely used type of brick lining at present. They are generally cheap in first cost, but better results can be obtained by careful selection of brands which are more expensive in first cost.

Neutral Bricks (Non-Fireclay Type).

These are nearly all high-priced bricks, which discourages the user at the outset. Moreover, it can be reasonably claimed that it is well, first of all, to explore the possibilities of improved service from relatively cheap materials, which possibilities are by no means exhausted.

Chrome Bricks, the most familiar of neutral bricks. Experiments with these have proved very contradictory, but failures seem attributable to spalling and successes to methods of use which tend to reduce spalling. It seems more than likely that by modified manufacture these bricks may be successful eventually.

Sillimanite—characterised as it is by extremely low expansion and theoretic neutrality might seem to be a useful material. It is, however, very susceptible to iron-oxide-bearing slags and is hardly likely to be used successfully (at any rate alone) for cupola linings. Among basic bricks, magnesite shows high cost, high expansion and conductivity and rather high-spalling tendency.

Rammed Linings.

Evidence on the vexed question of bricks *versus* rammed linings is so far contradictory as to leave one open-minded on the subject. Doubtless many failures could be avoided by proper attention to the blending and use of material, and this in conjunction with successful reports leads to the conclusion that it is possible, with economy in first cost and in service, to substitute rammed linings for brick.

The difficulties and necessary precautions are such, however, as to render the possibility of failure greater with rammed than with brick linings. One foundryman has very aptly said that in using a rammed lining the cupola becomes a brick kiln, and the brick manufacturers' difficulties confront the cupola user. It is known that the production of large refractory blocks is by no means easy—how much more difficult is it, therefore, to produce a one-piece lining! It can, however, be done successfully, but only as a result of careful study of the properties of raw as well as burnt refractory materials.

There is no need to go into the chemical analyses of ramming mixtures at length. The considerations resemble those applying to bricks. It seems that most rammed linings are siliceous and the foregoing remarks as to silica and clay mixtures apply. The main requirements in a material for rammed linings are well known. Refractoriness, mechanical strength at high and low temperatures, ability to glaze on the hot surface and to form a hard mass behind the glaze, free-drying characteristics, low shrinkage on drying and low-volume change on burning. Added to which is a need for "elasticity," so that the hard-burnt exposed face does not part from the half-burnt interior of the wall.

Mechanical strength at all temperatures from cold to that of cupola-melting zone is of paramount importance. It may be safely attained by wise blending of various refractory materials and bonds or may be a natural property of some earths or minerals. Perhaps it may be justly claimed that blended mixtures are better than natural earths, in that they have less tendency to vary. The cold-crushing strength of the compressed and dried material is a valuable guide.

Of almost equal importance is the drying shrinkage of the material, and in this respect many users fail to appreciate the drying properties of raw fireclays which enter into the composition of nearly all ramming materials. The drying of clays is to the brick manufacturer quite as important and difficult a matter as burning. In brickmaking as many or more faults in bricks are due to drying as to other features of the operation. Wet clays shrink approximately in proportion to the volume of water removed until they reach the "black" or "leather" hard state, in which they may be conceived as a mass of tiny particles each surrounded by an infinitesimally small film of water. From this state to the "white hard" or bone dry the shrinkage is very low. There might, in fact, be a slight expansion. Ramming materials, incorporating raw clay, should, therefore, be used in such a condition that the clay is very little wetter than "leather-hard" condition in which it is still capable of some deformation without cracking. The moisture content of any particular mixture should be studied in relation to volume shrinkage.

In drying bricks it is realised that a speed limit is set by the rate at which moisture can travel by capillarity from the centre to the skin of the mass. The passage of moisture can be facilitated by the addition of coarse non-plastic material such as sand, quartz or grog. The amount of plastic clay is thereby reduced and drying shrinkage lessened, since it is only this part which shrinks appreciably. The foregoing materials are present in successful ramming compositions and act in similar manner.

A low volume-change in burning is desirable, since raw clays tend to shrink when burnt (after drying). It is not advisable to use clay alone for ramming. Non-plastic material such as burnt clay (grog) or quartz rock or sand may be added. In siliceous mixtures the silica tends to expand and offset the shrinkage of the clay.

If there is anything in the suggestion that fireclay containing no free silica is an ideal cupola lining it is advisable to consider how such material could be used for rammed linings. The clay alone would tend to show high shrinkage and be too dense after ramming, thereby increasing drying difficulties. A plastic material will, however, "carry" a large amount of non-plastic material, and a complete fireclay ramming mixture with satisfactory properties can be made by pre-calcining a part and mixing this with raw clay. (By proper treatment it is possible to produce a plastic mixture containing 5 per cent. raw clay only, the rest being grog.) Grog mixtures such as this show very low volume change from green (moist) to fired, and there is evidence that they will form a very useful cupola lining, although, perhaps, rather more expensive in the first place than the siliceous mixtures commonly used.

The drying and first firing of monolithic linings should, of course, be very slow and thorough, and it is, moreover, advantageous to maintain rather higher temperatures than usual during the first few heats.

Mixtures of materials other than fireclay and silica are at present under experiment, there being evidence to encourage the use of certain refractory cement in the production of heat-resisting concrete. The same cement has proved admirable as a resistant joint in cupola brickwork, and the concrete would merely increase the number of "joints," the bricks being replaced by carefully-graded refractory aggregate.

Patching Materials.

These are almost universally siliceous—either natural or artificial mixtures of silica rock, ganister stone, or sand and fireclay. Much the same considerations apply to these materials as to ramming materials, especially as to chemical analysis, glazing properties, hardness behind the glaze and high mechanical strength when air-dried. As it is not the custom to ram patches into position in the cupola, a practice which might be well worth while, it follows that patching materials must in general be more plastic than those used for ramming. This means a greater proportion of clay with a corresponding tendency to greater shrinkage.

It is by now well known that if a patch is to adhere thoroughly to the old lining, whether this is brick or rammed, the surface of the old lining must be thoroughly clean and preferably washed over with a thin wash of the patching material or of fireclay. It is still, however, common to find patching materials applied in very wet condition, which, as suggested previously, causes serious shrinkage of the bonding clay. It is definitely essential that cupola patches be applied with as little moisture as possible, the quantity being merely sufficient to develop a stiff plasticity, and the material should not merely be daubed but should be either thrown or pressed on to the surface which is being repaired. Thick patches will tend to give trouble owing to high shrinkage in drying and burning, and the stress should be relieved in places which are badly worn by inserting brick-bats, splits, or some such coarse material.

Most of the patching material applied to a cupola wall is in many cases removed a few hours after melting begins. The reason is that the material is not properly dried when heat is applied, and moreover, the heating is very rapid. Unless the material has high mechanical strength when dried it will be removed by the mechanical action of the descending charges. Without doubt, therefore, the most satisfactory cupola patching materials will possess low drying shrinkage and appreciable mechanical strength when dry, and in addition they will not lose their mechanical strength when heated to moderate temperatures, thereby ensuring that the inner part of the patch is mechanically strong although it has not been sintered. The manufacture of cupola-patching material is therefore a matter for great thought and care, and especially in the quality and amount of fireclay which is added to give plasticity.

To ensure that the day-to-day patches applied to cupolas are thoroughly dried before being put into use an extra "stand-by" cupola is necessary. The newly-repaired cupola then stands for 24 hrs. before being required for melting, during which time the lining is slowly and thoroughly dried and cracks made up if necessary. A procedure such as this would at any rate enable the user to inspect a patch after drying and may illustrate clearly what happens to the patch when rapidly dried in the first stages of heating up prior to melting.

It is a matter for some surprise that users of a fireclay brick lining should regularly effect repairs with highly siliceous mixtures and leads

(*Continued on page* 376.)

Alloys Now Cast in Great Britain.*

By Thomas Henry Turner, M.Sc.

Introduction.

Every day the reader of metallurgical literature finds references to new alloys made by research workers, patented by inventors, or placed on the market by industrial concerns. How many of these are worth making? What alloys are actually cast by foundrymen?

In the preparation of this account of the alloys cast in his native land, the author has endeavoured to answer these questions by reviewing, to the best of his ability, the many alloys commonly available as castings. The data here reproduced are all the product of inquiries of individuals or firms actually engaged in the foundry business at the present time. The majority of the figures have been given as typical of castings made commercially, but in some few cases they are figures obtained by the author on testing samples given him by the producers. In no case has the data here given been abstracted from existing text-books, for text-books and scientific papers contain references to hundreds of alloys which have only been made once by one worker.

It is hoped that reference will be found to all the important groups of alloys, used as castings, irrespective of whether they are ferrous or non-ferrous. The standardised alloys are mentioned wherever possible, but in many cases the alloys have not yet been standardised.

Extensive as this review of present foundry practice may be, it inevitably suffers from gaps, due in part to the ignorance of the author and in part to the fact that all foundrymen have not yet accepted the truth that it is more blessed to give than to receive knowledge.

Nevertheless, if the following sections make a useful contribution to the international science of metallurgy, they do so because of the generous help the author has received from many British foundrymen and engineers who knew his objective and freely gave details of their practice or materials for use in this Paper.

The compilation of this data regarding current practice has entailed many works visits and much correspondence, and the author gratefully acknowledge his indebtedness to all who have so kindly helped him in his task, and especially to the British Engineering Standards Association for permission to make extracts from some of the British Standard Specifications relating to castings. A complete list of these standard specifications is given in the Appendix.

Cast Irons.

The use of standard specifications for cast iron has not become universal in Great Britain, as is practically the case with some of the more common non-ferrous foundry alloys. The reason for this is obvious, in that the types and varieties of cast iron are many, as are the purposes to which this material is put. Although customers occasionally quote B.E.S.A., Air Board or their private specifications, it is usually left to the foundry to supply the castings in the most suitable material. In this respect the degree of confidence existing between purchaser and producer is, therefore, an important point.

The strength, hardness and machinability of cast iron varies so greatly with changes in section, that this is necessarily considered in the B.E.S.A. Specifications. Breaking loads are therefore specified for test-bars from 0.75 to 2.30 in. in dia. in regard to many general grey-iron castings.

The attitude of makers and users of grey-iron castings towards chemical analysis has undergone much change in the last twenty years, but considerable latitude is still permitted as regards composition, as will be seen in the following references to individual specifications, some of which are prefaced by paragraphs such as the following:—

"The chemical compositions called for in the British Standard Specifications for cast iron and malleable cast iron for automobiles are considered to be of less importance than the mechanical tests required. The limits of the compositions, accordingly, have been set as wide as possible and represent the extreme proportions of the different constituents which may be present in a good and serviceable material. It is considered desirable, therefore, in the use of these specifications that the mechanical properties should be regarded as the main requirements and the chemical composition as an auxiliary check upon the suitability of the material to perform the duties laid upon it.

"Further, it is recommended that with each batch of castings delivered the manufacturer should furnish to the purchaser a signed certificate giving the results of the chemical analysis and mechanical tests carried out."

Many of the B.E.S.A. Standard Specifications for cast-iron articles concern themselves almost exclusively with dimensions, tolerances and such purely engineering details.

Pipes and fittings must be made according to specifications which have been in use for nearly twenty years, from "remelted iron and the metal shall be dark grey on fracture," but the metal composition is in no way specified.

In some cases it is specified that the re-melting shall be in the cupola or air-furnace.

The recently issued B.E.S.A. Specification for *General Grey-iron Castings*, Grades A and C (No. 321—1928), states that the castings shall be cast from metal melted in any metallurgical plant, other than an iron-ore smelting furnace. This is somewhat different wording from that in the older specifications referred to above, but it means much the same. The chemical composition of the iron as cast to this recent specification is again left to the discretion of the manufacturer, but, if desired, the purchaser may specify a maximum percentage of phosphorus. Breaking loads are very carefully specified in this specification for test-bars from 0.75 to 2.30 in. in dia.

In several specifications drawn up in 1924 the chemical composition only limits the sulphur and phosphorus contents; in all cases 0.12 per cent. being the maximum for sulphur and 1.20 per cent. being the maximum for phosphorus.

For iron castings for air-cooled and jacketed cylinders for automobiles (No. 5024—1924) no heat-treatment is permitted. This also applies to iron castings for flywheels for automobiles (No. 5026—1924), but heat-treatment up to 500 deg. C. is permitted for piston castings, after they are removed from the mould, according to the specification for iron castings for sand-cast pistons and valve guides for automobiles (No. 5025—1924).

Piston-Ring Pots.

A more recent specification (No. 5004—1927) for *cast-iron piston-ring pots*, sand cast and chilled cast, for automobiles, specifies the analysis fully, and also standardises the methods of taking the samples. The analyses ranges permitted are as follow:—*Sand Castings*, T.C., 3.50 max.; C.C., 0.55 to 0.80; Si, 1.80 max.; Mn, 0.40 to 1.20; S, 0.12 max. and P, 1.00 per cent. max.; *Chill Castings*, T.C., 3.50 max.; C.C., 0.45 to 0.80; Si, 1.80 to 2.50; Mn, 0.40 to 1.20; S, 0.12 max. and P, 1.00 per cent. max.; and these same analysis limits are fixed in the later specification (4 K.6—1928) which also applies to cast-iron piston-ring pots.

Two other specifications give chemical limits for cast irons, namely, those for *pistons and water-cooled cylinders* (K.11—1919), and *valve guides and air-cooled cylinders* (K.12—1919). These are set out in Table I:—

Table I.—*B.E.S.A. Cast Iron for Pistons, Water-cooled Cylinders, Valve Guides and Air-cooled Cylinders.*

	K.11 (A).	K.11 (B).	K.12.
T.C.	2.7 — 3.5	2.7 — 3.3	2.7 — 3.5
C.C.	0.5 — 0.8	0.5 — 0.8	0.5 — 0.8
Si	1.2 — 1.8	1.2 — 1.8	1.2 — 2.0
Mn	0.35— 0.80	0.6 — 1.2	0.5 — 1.2
S	0.12 max.	0.12 max.	0.08 max.
P	0.80 max.	1.1 max.	0.80 max.

Malleable Cast Iron.

Two B.E.S.A. Specifications are now in force for "*White Heart*" *and* "*Black Heart*" *malleable iron castings* (Nos. 309 and 310 respectively—1927). These do not apply to light castings which are to be subjected to hydraulic, steam or air pressure tests, and they rely almost entirely on mechanical tests. Sulphur and phosphorus contents are, however, limited, and it is required that tensile test-bars and bend test-bars, cast and heat-treated as carefully specified, shall give the minimum figures shown below.

The bend test-bars used for malleable cast iron are 8 in. long, 1 in. wide and $\frac{3}{8}$ in. thick. The edges may be rounded to a radius not exceeding $\frac{1}{8}$ in., and they are tested by being bent, cold, without machining, through an angle of 45 deg. or 90 deg., as the case may be, round a radius of 1 in. without showing signs of cracks or flaws.

Table II.—*B.E.S.A. Malleable Cast Irons.*

	"White Heart."	"Black Heart."
Max. S content	0.40	0.10
„ P „	0.20	0.20
Min. U.T.S., tons/sq. in. ..	20	20
„ El. per cent. on 2 in...	5	7.5
„ Bend	45 deg.	90 deg.

The above are the only British Standard Specifications in force for malleable cast iron; the other relatively recent specifications (5022—1923 for Automobiles and K.17 and K.18—1925 for Aircraft Ground Equipment) having been withdrawn and cancelled. Actually, the particulars in Table II are the same as in the recently-cancelled specifications, but for the fact that silicon and manganese maxima were also stated in the latter.

Table III.—*Cylinder Irons.*

	No. 1.	No. 2.	No. 3.	No. 4.
	Per cent.	Per cent.	Per cent.	Per cent.
C.C. ($\frac{1}{2}$-in. section)	0.6	0.6	0.65	0.55
T.C.	3.2	3.2	3.1	3.4
Si	1.9	1.4	1.8	1.2
Mn	0.80	0.80	0.80	0.70
S	0.08	0.08	0.08	0.08
P	0.90	0.90	0.25	0.60
Ni	—	—	1.25	—
Cr	—	—	0.35	—
Ultimate Strength (on $\frac{1}{2}$-in. sq. section turned from 1$\frac{1}{4}$-in. cast bar), in tons per sq. in.	13–17	13–17	15–20	13–16
Transverse Test (1-in. sq. cast bar, 12-in. centres), in cwts. ..	28	28	33	28
Deflection, in in.	0.1	0.12	0.12	0.1
Brinell Hardness—				
$\frac{1}{2}$-in. section ..	210	220	230	220
1-in. section ..	185	200	215	200
1$\frac{1}{2}$-in. section ..	170	180	195	180

* Official Exchange Paper written at the request of the Institute of British Foundrymen for the French Association Technique de Fonderie. The Author is Lecturer in Metallurgy at the University of Birmingham.

Analysis, together with physical and mechanical properties of the more commonly used *Cast Irons*, are given in Table III, supplied very kindly for this purpose by an automobile and general engineering foundry whose works are in the Midlands.

Nos. 1 *and* 2 are used for automobile castings; No. 1 for lighter cylinder blocks up to 2,000 c.c. capacity, and for air-cooled cylinders and general light castings, such as cover plates and small housings. No. 2 is used for heavier work. *No.* 3 is a nickel-chrome iron; its use up to the present has been mainly in experimental cylinders. It may be said that inquiries for suitable castings in nickel-chrome irons have increased very considerably during the last twelve months. From reports to hand on the application of nickel-chrome cast iron to air-cooled cylinder blocks, the superiority of this material as regards wearing properties is very marked. It is anticipated that, in due course, when the technique of their preparation and knowledge of their properties in service is further advanced, that the use of nickel-chrome cast irons will greatly increase. *No.* 4 mixture is used for general hydraulic work, such as large centrifugal pump bodies and similar castings.

Semi-Steels and Common Iron Mixtures.

As is well known, the casting and other properties of cast-iron mixtures are a function of the types and grades of the pig-irons used. Cheaper mixtures cannot be successfully employed for the better-class work on this account. Data of typical semi-steel mixtures used are given in Table IV:—

TABLE IV.—*Semi-Steels and Common Iron Mixtures.*

	10 per cent. S.S.	25 per cent. S.S.
	Per cent.	Per cent.
T.C.	3.2	3.2
Si	2.0	1.7
Mn	0.7	0.6
S	0.1	0.1
P	0.6	0.5
Ultimate Strength (in tons per sq. in.)	12–18	13–18
Transverse Strength (in cwts.)	26	28
Brinell Hardness—		
½-in. section	200	215
1-in. section	180	195
1½-in. section	160	175

These mixtures are employed for commoner castings, where service demands are less severe, and where variations in sections, etc., do not make too severe demands on their casting properties.

In general, it may be said that the demand for the better-class (cylinder) irons is increasing, since the trend of design calls for castings in more complex shapes and consequently more difficult to cast soundly, with a minimum of porosity and liquid shrinkage.

This demand for better-class cast iron has led to a practical application of the knowledge gained by researches on the effect of intentional additions of nickel, chromium, manganese, silicon, titanium and other elements to cast iron, which is already, in its simplest form, an almost bewilderingly complicated alloy. Three Papers read at this year's Convention of the Institute of British Foundrymen, in London, show that real progress has been made in connection with the commercialisation of alloy cast iron.

The use of about 14.25 per cent. of silicon in acid-resisting cast iron, and of high percentages of nickel and manganese in non-magnetic cast iron, has been well known, but the extent to which the smaller percentages of *nickel and chromium* are now being added to cast irons in Great Britain is not such common knowledge, as was shown in the discussion, last June, of Dr. Everest's Paper.*

The list only contains irons with relatively low silicon contents used to give superior mechanical properties. A famous London firm of engineers has kindly pointed out that for thin sections, such as instrument cases, where easy machining is essential, they have found useful an iron with 3½ per cent. silicon and 2 per cent. of nickel. For much the same reason, 1 to 1½ per cent. of nickel has been added to low-silicon cast irons, stabilised with chromium for heat-resisting purposes, the nickel being used to retain toughness and machinability. Similarly, some grain rolls have been recently cast with ½ per cent. of nickel added, to aid in producing a good close grain and hard surface.

The *non-magnetic cast iron* which was introduced years ago under the Ferranti-Dawson patent is still cast, and is being extensively used in the electrical industry in places where hysteresis and eddy current losses are objectionable, and it is also cast into thin-sectioned electrical resistance grids on account of its high specific resistance in comparison with other materials, which, combined with its low-temperature coefficient, enables the maximum capacity to be concentrated in the minimum bulk. "*Nomag*" is also cast into castings many feet in diameter and many tons in weight. This alloy contains approximately 10 per cent. nickel, 5 per cent. manganese and the remainder cast iron.

Various other special alloy cast irons are now being cast commercially in Great Britain by adding sufficient special elements to make the microstructure austenitic. These *austenitic cast irons* are all non-magnetic, resistant to corrosion, and resistant to deformation and oxidation in service at high temperatures.

A typical example of such austenitic cast irons contains about 20 per cent. of nickel and copper, added as Monel metal. This possesses really remarkable resistance to certain types of corrosion, and to oxidation and growth at high temperatures. It has proved more satisfactory than brass, gunmetal or cast iron when used for the components of pumps in chemical factories. Although it was introduced originally in America as a cheap substitute for brass, it has the wearing qualities of cast iron and approximately the same coefficient of expansion, so that it can be used in conjunction with ordinary cast iron. Its ultimate tensile strength is 9 to 12 tons per sq. in., with an elongation of 1½ to 2½ per cent. and a Brinell hardness of 140. Its present use in Great Britain appears to be frequently on account of its resistance to growth and scaling at high temperatures, and it thus seems to be worthy of notice as it contains so much less of the expensive alloying elements than do the normal heat-resisting alloys.

(To be continued.)

* See FOUNDRY TRADE JOURNAL, page 61, July 25, 1929.

American Foundrymen's Association.

The 1930 Nominating Committee of the American Foundrymen's Association was completed recently with the election of four members by a letter ballot of the Association membership, returned November 4. Election judges canvassed 816 votes, declaring the following elected to the committee: Mr. M. J. Evans, Vice-President, Whiting Corporation, Harvey, Ill.; Mr. R. J. Doty, Plant Manager, Reading Steel Casting Company, Reading, Pa.; Mr. W. J. Grede, President, Liberty Foundry, Inc., Milwaukee, Wis.; Mr. T. H. Addie, President, American Manganese Bronze Company, Philadelphia, Pa. The past-presidents automatically members of the 1930 committee are Mr. A. B. Root, jun., Hunt-Spiller Manufacturing Corporation, Boston, senior past-president and chairman of the committee; Mr. S. W. Utley, Detroit Steel Casting Company, Detroit, and Mr. S. T. Johnston, S. Obermayer Company, Chicago.

AN AMALGAMATION between the Société des Forges de Montataire and the Société des Laminoirs de la Sambre is announced.

Conditions in the German Iron-Foundry Industry.

J. E. Wallis, jun., Trade Commissioner, of Berlin, writing in "Commerce Reports" of October 21, states that the Association of German Iron Foundries, organised in Düsseldorf in the year 1869, has played a most important part in developing German foundry industry to its present prominent place in the industrial life of the nation.

German foundry production for the year 1913, based on the post-war area of Germany, amounted to 3,090,000 tons, as against 2,000,000 tons in 1926 and 3,100,000 tons in 1927. All classes of foundry products shared in the increase of 1927 over 1926, although the greatest gain was that in industrial castings. At present the production of machine castings is below that of 1913, although the production of other types of castings has increased.

In general, the German iron foundries form one of the most important branches of Germany's heavy industry. In the number of persons employed and value of production, they take rank with the blast furnaces, steel plants and rolling mills. German foundry production in 1927 was valued at 982,200,000 reichsmarks, as compared with an output of pig-iron valued at 986,000,000 reichsmarks.

Present conditions in the industry are, on the whole, considered unsatisfactory. The report of the Association states that the demand for machine castings has become somewhat better in recent months, although the financial returns from this branch of the industry have not been in proportion to the increase of plant activity. This has been largely due to inadequate price conditions. A marked increase in the demand for high-quality castings has recently become noticeable, but it is believed that the next few months will show no marked improvement, so far as the requirements of the machinery industry are concerned.

Among the most important finished products of the German foundry industry are stoves, cooking ranges and heating equipment. The business in stoves and other heating equipment has been satisfactory, owing very largely to the severe winter of 1928-29, when the demand was exceptionally great. Orders on hand are expected to keep many foundries at a high point of activity for considerable time.

Exports of foundry products during the first eight months of 1929 remained at approximately the same level as in the corresponding period of last year. It is reported that German foundries are meeting with sharp competition from Belgium, France, Poland, Czecho-Slovakia and Italy, and only the better quality of the German product can be exported.

Iron and Steel Output in October.

The National Federation of Iron and Steel Manufacturers report that the number of furnaces in blast at the end of October was 166, a net decrease of two since the beginning of the month, two furnaces having been blown in and four blown out. The production of pig-iron in October amounted to 688,700 tons, compared with 664,600 last September and 543,600 tons in October, 1928. The production included 208,100 tons of hematite, 299,800 tons of basic, 133,400 tons of foundry and 21,700 tons of forge iron. The October output of steel ingots and castings amounted to 889,800 tons, compared with 847,900 last September and 756,000 tons in October, 1928.

THE POLISH MINISTER FOR COMMERCE has again refused an application from the Polish Iron Syndicate to be allowed to raise selling prices by 10 per cent. The question of prices is to be settled at a meeting with representatives of the Syndicate.

Junior Scottish Foundrymen Open New Session.

The opening meeting of the session was held in the Cadora Restaurant, Glasgow, on October 26. In the unavoidable absence of Mr. J. M'Arthur, the retiring President, the chair was occupied by Mr. H. Winterton, President of the Scottish Branch.

The Chairman, in welcoming the members at the opening of the session, made reference to the diffidence of the juniors in attending the meetings, and expressed the hope that the social meeting to be held later in the evening would assist in dispelling that diffidence. It was his duty, as President of the Scottish Branch, to do all in his power to assist the junior section, a duty which he would find great pleasure in performing, as he could assure them he had a very special interest in their welfare.

He now had the pleasure to introduce the new President of the section. Mr. M'Nab had served as junior and senior vice-president and had taken a very active interest in the proceedings of the junior section from its inception. He asked for the new President the same co-operation and assistance as had been accorded previous occupants of the position. He now had pleasure in introducing Mr. M'Nab and asking him to deliver his presidential address.

Mr. M'Nab, on taking the chair, thanked Mr. Winterton for his kind appreciation of his services and the members for the honour in electing him to the presidential chair. He appealed to all the members to assist him in increasing the popularity and usefulness of the junior section.

Presidential Address.

Mr. M'Nab then delivered his address as follows, and in part said:—

Mr. Winterton and Gentlemen,—I would like to thank you for the compliment that you have paid me in electing me to the office of President of the Scottish Junior Section.

The Junior Section of the Scottish Branch was formed two years ago by the efforts of several members of our parent body, who thought that it was time that the young foundrymen had a meeting ground. An inaugural meeting was held, which took the form of a visit to the works of Messrs. G. & J. Weir at Cathcart. There was an attendance of over three hundred. During the first session the support we received was excellent, but I am sorry to say that last year there was a considerable falling off in membership and attendance. The syllabus was not of an uninteresting nature, I think that those who did attend will agree that the Papers submitted were of outstanding merit, and the subjects dealt with of a wide variety, embracing many branches of the trade.

Not the least interesting part of the meetings we hold are the discussions which follow the reading of each Paper. Many of us take these opportunities to express our views—a thing that we lack the confidence to do at the Senior meetings—but it would be nice to see more people joining in. There are few who have not something of value to say, and it must be borne in mind that their contributions, when withheld, are often lost for ever.

Popularity of Works Visits.

It has been noticeable during the last two years that works visits have been very popular, and with this in view the construction of this session's syllabus includes fewer formal meetings in the Royal Technical College, and the number of works visits has been increased. These outings are most instructive, and it is always interesting to see how the other man carries out his job. No one can possess an intimate knowledge of every trade, or, for that matter, every branch of one trade, but, by visiting other works, one gathers information which may be of future use. It is often found that rare problems, encountered at one's own job, are satisfactorily solved by applying principles used daily in some other sphere. The modern tendency is all for specialisation, but there is little doubt that the man who, besides having a specialised knowledge of his own trade or profession, has a superficial grasp of associated trades, is in a strengthened position indeed.

Foundry Progress.

During the past few years many improvements have been made in foundry practice. For instance, a few years ago, oil-sand was considered an expensive luxury which few could afford; nowadays, even the smallest and most old-fashioned foundries have come to realise that this new method of core-making is applicable to their work. That this has been a process of evolution rather than revolution points to that streak of conservatism present in most foundrymen. Again, moulding machines are much more popular to-day than they were formerly, but here, again, they were only accepted by the trade in general after they had thoroughly proved their worth. It is fortunate that there are firms who can afford, and are willing, to try out new departures, because it would indeed be foolhardy for small firms to expend large sums of money on what must be looked upon as experimental work.

While on this subject I might draw attention to the recent remarks of a Branch President, who visualised the day when moulding machines would be universal, and would be capable of making all kinds of moulds from start to finish without the necessity for any hand work at all. I do not think that we will reach this stage for a long time.

Progress has no doubt been retarded during the past few years by the trade depression which has been hanging over us, and most of the members here this evening have never had the experience of working during a boom period. However, there are now signs that this slackness is passing, and those in a position to speak with authority inform us that they are confident for the future. This country has in the past made a name for itself as a producer of first-class articles, and the castings made in our foundries are no exception. We of the younger generation of foundrymen must, therefore, realise that we have a fine tradition to preserve.

Apprentice Training.

At a meeting last year we held a symposium on apprentice training, and some very interesting views were put forward. This question has recently been receiving a great deal of attention, and everyone is agreed that, owing to altering conditions, apprentice training is becoming increasingly important. Those entering our foundries to-day must be given every opportunity of gaining a thorough grounding in as many branches of the trade as possible. Even in purely jobbing shops this is sometimes neglected, and often boys are allowed to work for long periods on one particular job. Very occasionally this is because the apprentice is looked upon as a cheap form of labour, but, generally speaking, it is due to lack of thought on the part of those in charge. It is my opinion that an apprentice gets the kind of training that he wishes. If he is willing to jog along, doing the same job day in, day out, he is often left to it; should he express a desire to get a variety of work he usually has only to ask for it. My advice is that whenever you feel that you are getting stuck for too long a period on one particular class of work, go to the foreman and explain to him that you would like experience at something else. Usually he is quite willing to help you. The foreman has a great deal to think of, and, while some men have a *flair* for training boys, there are many who are quite as good at their jobs and yet lack this valuable gift.

An important part of an apprenticeship is the attendance at evening classes, and it is to be regretted that in many districts there are no courses specially arranged for foundry students. This is sometimes due to lack of enthusiasm on the part of the apprentices themselves, for two courses in this district had to be discontinued because of the scanty support given to them.

Vote of Thanks.

Mr. John Longden said: I have very great pleasure in proposing a vote of thanks to Mr. M'Nab for the address which he has just delivered. I have listened with much interest to the manner in which he has dealt with some of the problems facing foundrymen to-day. I agree with most of the remarks he has made regarding the question of apprenticeship, and trust that the Junior Section will have a very profitable and successful session.

Mr. M'Nab said that he greatly appreciated the kind manner in which they had received him and for the vote of thanks which they had passed.

Mr. Winterton said that the next item on the agenda was the reception, but as the donors of the entertainment wished to remain anonymous that must necessarily be omitted. As President of the Scottish Branch, he welcomed them to what he trusted would prove a very pleasant and enjoyable evening. He would like to take this opportunity of referring to the Buchanan and Surtees medals, which would be offered for competition this session. With the Buchanan medals, it would perhaps interest them to know that he had recently had a talk with a daughter of Mr. Robert Buchanan, who was very much interested in the competition and very much appreciated the action of the donor in commemorating her father's connection with the Institute. She had presented the previous evening the medal won by Mr. Hird, of the Birmingham Junior Section.

He was afraid that there had been some little misunderstanding about the conditions of the competition. He wished to impress on them that it was not essential that they attend *every meeting* of the session to become eligible, because the conditions of the competition require a résumé of the session's work and the candidate's impressions of the work done during the year and opinion as to the various points raised. He appealed to them all to enter the competition and to attend the meetings and take part in the discussions with a view of increasing their knowledge. Both medals were instituted to commemorate very prominent foundrymen who were keen on the juniors coming forward to take up foundry work.

Mr. N. Blythe said he had pleasure in asking them to accord a hearty vote of thanks to the donor of the entertainment, to Mr. and Mrs. Winterton, and to Mr. J. Bell, the secretary, for making the arrangements. The vote was carried with acclamation.

Mr. Winterton thanked them, and said that both he and Mrs. Winterton were delighted to be present. He was glad that Mr. Bell had been included in the vote of thanks—he was glad to acknowledge once again the services of Mr. Bell to the Institute.

The evening was devoted to whist, music and dancing, and Mrs. Winterton presented the prizes to the winners in the whist competition.

Rust-resisting Steel.—In a contribution to a recent issue of "Stahl und Eisen," Herr Ed. Maurer gives an account of the development of rust-resisting steel, in which he claims to have been the first to discover (in September, 1912) the rust-resisting property of some steels containing a certain percentage of chrome after reading the accounts of Friend, Bentley and West. The title of the article is "Maurer's Manganese Steel in the Development of Non-rusting Steels."

P.-M.-G. Metal.

A SUBSTITUTE FOR GUN-METAL AND PHOSPHOR-BRONZE.

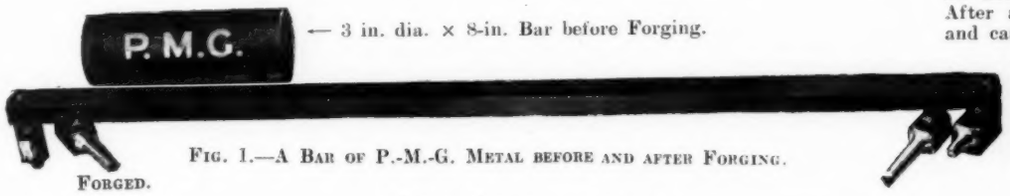
An interesting foundry problem has been solved by the technical staff at the Naval Construction Works (Barrow-in-Furness) of Messrs. Vickers-Armstrongs, Limited. In common with the majority of foundrymen, the staff had no particular love for Admiralty gun-metal, with its poor casting properties, its relatively long freezing range and the high cost of tin. The problem has been solved in quite an extraordinary manner, because the resultant alloy is, so far as at present can be ascertained, superior in every way and has shown itself to be so versatile that it can replace phosphor-bronze on economic and practical grounds, as well as do more than the duties normally specified for 70:30 brass and 9 per cent. aluminium-bronze. Its use then apparently will allow of a considerable reduction of the numbers of alloys used in and about large engineering works.

Our representative recently availed himself of an opportunity to investigate the manufacturing conditions of P.-M.-G. metal. The majority of the material going through the shops was destined to replace Admiralty gun-metal of standard composition, that is, 88 per cent. of copper, 10 per cent. tin and 2 per cent. zinc. P.-M.-G. metal is a copper alloy like gun-metal, but in this case the 10 per cent. of tin is replaced by a hardener, the nature of which is a subject-matter of a commercial patent. We were assured that the saving in cost was at least 15 per cent., the hardener actually being cheaper than copper. We did satisfy ourselves, however, that cost of raw materials apart, the new alloy should reduce wasters on account of its excellent casting properties. This is to be associated with a short freezing range, stated to be only 50 deg. C.

Melting practice was being carried out in pit fires of the usual type, the conditions being exactly the same as for gun-metal, except that less notice was taken of the casting temperature. After adding the zinc, the metal was stirred and cast into either dry or green-sand moulds. Very little dross was observable, whilst the metal was obviously of a very low viscosity.

Moulds.

For dry-sand moulds, Scotch rotten rock was being used, whilst for green sand, Mansfield "brass" sand has been standardised as normal. In both cases the control is left to the discretion of an experienced foreman. The face-dressings used, for both green- and dry-sand work, are Lithite ore or terra-flake. The green-sand moulds are dusted with either of these preparations, whilst dry-sand



— 3 in. dia. × 8-in. Bar before Forging.

FIG. 1.—A BAR OF P.-M.-G. METAL BEFORE AND AFTER FORGING.

Vickers-Armstrongs Limited BARROW-IN-FURNESS.

TESTING DEPARTMENT REPORT OF RESULTS OF TENSILE TESTS. Date May 18th 1929

Forged P. M. G. Metal

No. of Cast	Mark	Original Size of Test Piece: Width	Thick	Area	Yield: Tons	Tons sq. in.	Breaking Stress: Tons	Tons sq. in.	Contraction of Area at Point of Fracture: Width	Thick	Area	Per cent.	Elongation: Original Length	Per cent	Benders: Diameters	Rads.	Angle (bent)	QUANTITY AND DESCRIPTION	Engine or Ship No.
		·564	·25		11·6	18·4	8·0	32·0					2"	32				Finished Forging Temperature = Cherry Red	
		·564	·25		6·3	25·2	8·7	34·8					2"	32				— do — = Full Red	
		·564	·25		9·0	36·0	10·5	42·0					2"	17				— do — = Black	

A. Eastley Foreman of Testing Dept.

FIG. 2.—MECHANICAL TEST RESULTS OF FORGED P.-M.-G. METAL.

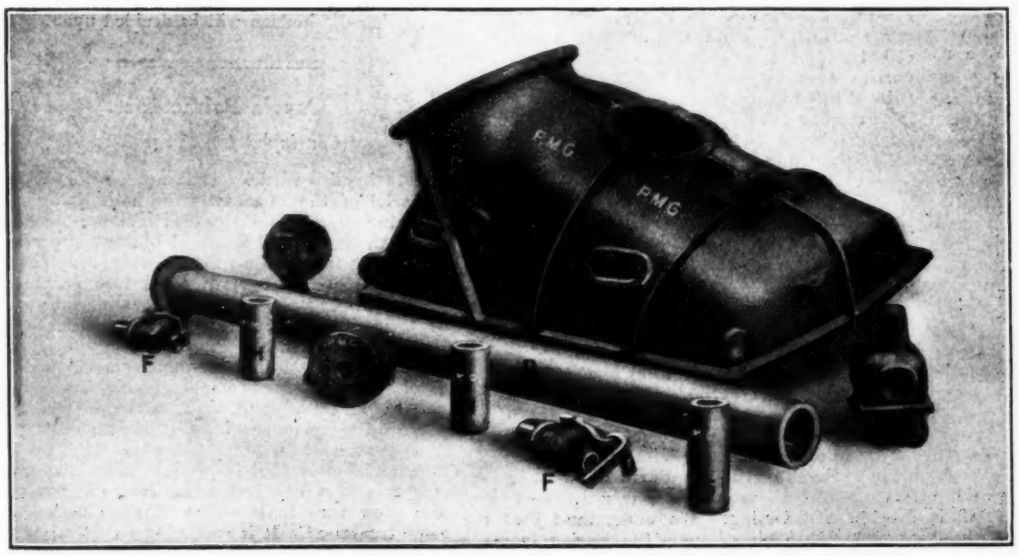


FIG. 3.—A GROUP OF CASTINGS MADE IN P.-M.-G. METAL.

They are:—*a*. Port forward condenser door, 8 ft. 6 in. wide, $\frac{7}{16}$-in. thickness of wall. *b*. Propeller shaft liner. *c*. Feed regulator body for evaporator. *d*. 4th stage valve box for engine air compressor. *e*. 3rd stage valve box for engine air compressor. *f*. 2-in. h.p. voice cock body. *g*. Bush for special bearings. *h*. Bushes for shaft bearings.

FIG. 4.—UPPER: TYPICAL APPEARANCE OF ADMIRALTY GUN-METAL. LOWER: TYPICAL APPEARANCE OF P.-M.-G. METAL.

work is washed with a liquid composition of plumbago and lithite. The skin produced is so good that no sand blasting has been found necessary.

Mechanical Tests.

Dr. Hanson, Feeny Professor of Metallurgy at the University of Birmingham, has made a series of seven tensile tests on bars cast in dry

Fig. 5.—A Ball Valve of $\frac{3}{16}$ in. Wall-thickness which burst at 4,700 lbs. per sq. in. Water-pressure.

sand and the average of finds are:—The yield point is 11.8 tons per sq. in., the ultimate stress 21.4 tons per sq. in. and the elongation on 2 in. 11 per cent. In every case the fracture was reported as being "fine-grained." The bars were described as being "all very sound and no defects, pinholes, etc., were revealed during machining."

Whilst not of such direct interest to our readers, it should be noted that P.-M.-G. can be readily forged when hot. If the material is finished at black heat, it apparently does not become brittle, though the tensile strength is increased from about 30 to 40 tons per sq. in., with a reduction in the elongation from about 36 to 17 per cent. on a 2-in. length.

The Brinell number of P.-M.-G. in the as-cast condition is in the region 110 and when forged 145. Probably the most striking feature of the new alloy is that the density of the cast and the forged material is the same at 8.4.

Heat-Treated P.-M.-G.

According to Dr. Hanson, the properties of both the cast and forged material may be improved by a heat-treatment consisting of quenching from 800 to 900 deg. C., with or without reheating, but reheating beyond 350 deg. C. is not recommended as it may have a detrimental effect on the tensile strength and elongation.

Comparison of Cast P.-M.-G. Metal with Admiralty Gun-Metal.

In the following table the properties of cast P.-M.-G. metal are compared with those of Admiralty gun-metal (88-10-2 mixture). The properties of gun-metal vary considerably according to the quality of the casting, and the figures given represent average results for good castings. The requirements of the British Admiralty specification for gun-metal are also included.

Test.	P.-M.-G metal.	Admiralty gun-metal.	Admiralty specification.
Yield point, tons per sq. in.	10–13	10	—
Ultimate stress, tons per sq. in.	18–26	16–18	16
Elongation, per cent. on 2 in.	9–18	15	7.5
Brinell hardness	107–121	60–70	—
Izod test, ft.-lb.	9–12	9	—
Density—			
Perfectly sound metal	8.45	8.88	—
Commercial castings ..	8.45	8.4–8.75	—

Comparison of the Properties of Forged P.-M.-G. Metal with worked 70/30 Brass and 9 per cent. Aluminium-Bronze.

In the following table the figures all refer to metal that has been annealed and cooled slowly.

Test.	P.-M.-G metal.	70/30 brass.	9 per cent. al.-bronze.
Yield point, tons per sq. in.	14.0	6	12
Ultimate stress, tons per sq. in.	31	25	30
Elongation, per cent. on 2 in.	48	65	30–40
Brinell hardness	113	60	105–120

Data are available to show that P.-M.-G. metal is a desirable material for extensing into bars; that as a bearing metal is presented on test properties superior to phosphor-bronze and gun-metal; that under "windmill" testing conditions—the laboratory method of representing a wet and dry sea-water corrosion test—the P.-M.-G. metal is only 72 per cent. as corrodable as gun-metal. The salt-water spray test gave results which showed the P.-M.-G. metal to be about 3 per cent. better than gun-metal.

The method of testing the erosion-resisting properties was new to us, and consisted in screwing four nozzles of different alloys into the same casting, which formed the end of a high-pressure water-pipe line. The duration of the test was 46 hrs. and the pressure 1,500 lbs. per sq. in., with an approximate velocity of 450 ft. per sec. through each nozzle. The nozzles were weighed before and after the test with the following results:—The loss in weight in grammes of P.-M.-G. metal was 0.0022; Admiralty gun-metal, 0.0040; phosphor-bronze, 0.0036 and manganese-bronze, 0.0050.

We are sure that no firm, especially one of the standing of Vickers-Armstrongs, Limited, would take umbrage at our personal conclusions, which are, so far as laboratory tests have shown, P.-M.-G. metal is an alloy of great promise, but the final *caché* of universal excellence can only be given after several years of practical industrial application. Its casting and common mechanical properties commend themselves to all founders as providing a cheaper and better alloy than normal Admiralty gun-metal. Naturally this is a personal opinion, but it can be verified by our readers, as an open invitation is extended by Messrs. Vickers-Armstrongs to all founders to visit the Barrow Works and to examine for themselves the conditions of production and testing. We understand that the alloy has been placed upon the market in ingot form for remelting, and in this connection data are available which show that, so far as six remeltings are concerned, no deterioration of properties manifested itself.

Within the space of a week 30,000 tons of new shipping have been ordered from Wear firms. Messrs. William Doxford & Sons, Limited, have secured orders for two vessels for Scandinavian owners, and Sir James Laing & Sons and Messrs. J. L. Thompson & Sons, Limited, each an order for one ship. Sir John Priestman & Company are also laying the keel of a new vessel.

The Aim of Rationalisation.

In a Paper read at a meeting of the Royal Philosophical Society of Glasgow recently, Mr. J. R. Richmond presented an exposition of the principle of rationalisation. He discussed factors affecting the accelerated development of rationalisation, and spoke of forms of combination. After describing the development and effects of rationalisation in various countries, Mr. Richmond said that America was the pioneer in business combination, largely, in the first instance, for distribution, prices and selling purposes, and it was perhaps significant that rationalisation proper began there primarily on the technical side. One of the chief features in a rationalisation process was what was termed integration, by which was meant the location of the various elements of plant in one place, making up a chain sequence of process from the raw material to the finished product. It aimed at eliminating the cost of transport charges and the reduction of transfer of material to the minimum, and of adopting the best mechanical means of securing such transfer. Mr. Richmond also dealt with the features of the competitive system and the economies resulting from large scale production.

International Steel Cartel.

The Executive Committee of the International Steel Cartel in Luxemburg has unanimously decided to reduce the tonnage of production provided for in the current programme by 10 per cent. as from February 1 next. This will reduce the total tonnage from 32,295,770 to 29,066,190. The decision has been reached in consequence of the state of the export market in steel. In view of the congestion caused by over-production, fifty-seven Belgian founders have decided to reduce their output by 10 per cent. as from November 11. Should this measure prove insufficient to improve the state of the market, a further diminution will be decided upon.

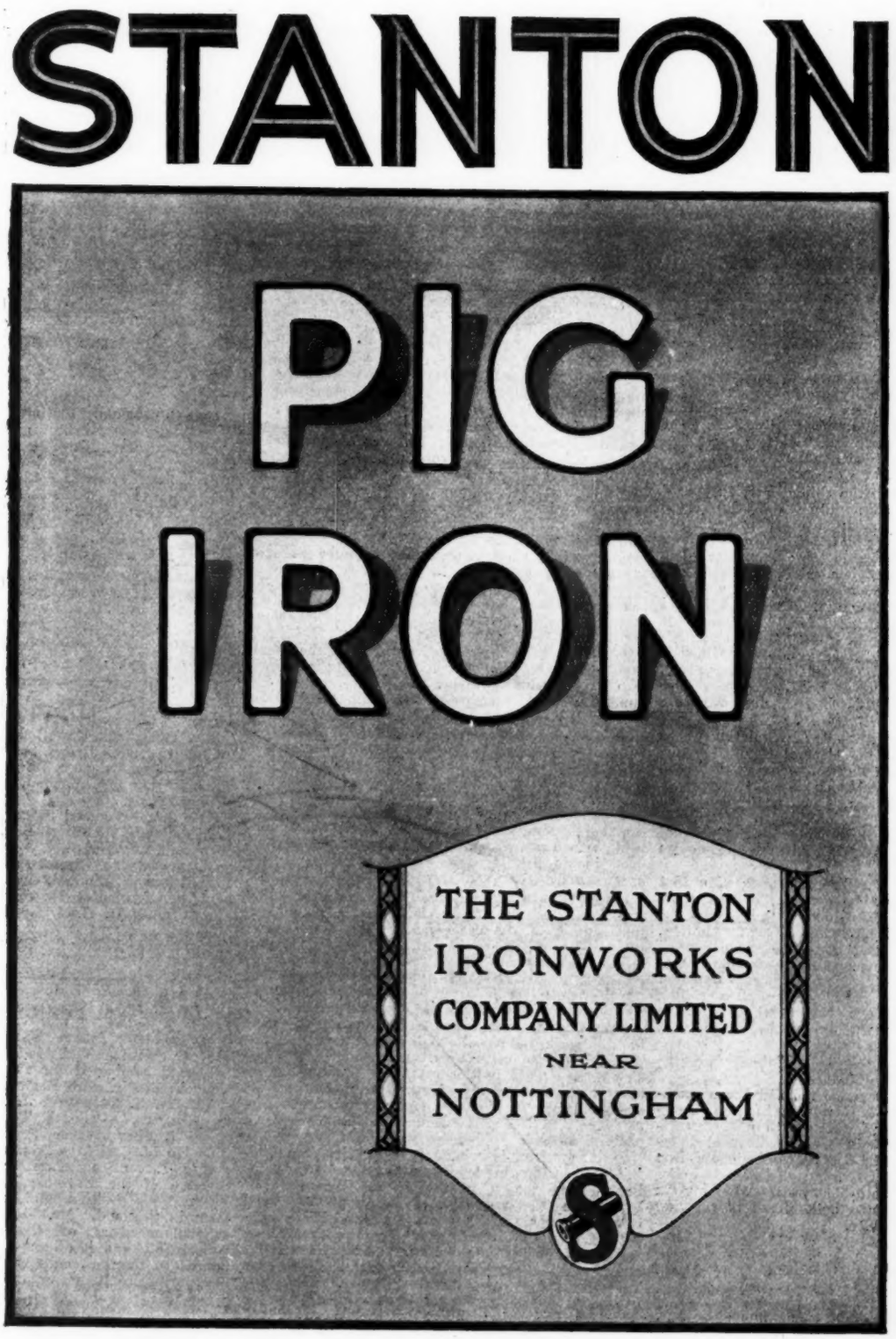
Cupola Refractories.

(*Continued from page* 371.)

one to inquire whether it is not possible to use material of the same type for both lining and patching. On lines similar to those outlined under the heading "Rammed Linings" it would be possible to evolve a satisfactory fireclay patching material composed of a mixture of plastic fireclay in the smallest possible amount with grog or burnt fireclay carefully graded. The popularity of siliceous patching materials may perhaps be explained on the grounds that expansion of raw unburnt silica compensates for the shrinkage of the clay, and such mixtures certainly prove on test to show very little volume change indeed after drying and burning. By proper blending, however, it is possible to produce fireclay mixtures containing no free silica which also show very little volume change under the same treatment. It is well known that mixtures of this type give excellent results in building and in repairing the firebrick walls of other furnaces, notably combustion chambers on boiler plant.

It is suggested that even allowing for the greatly improved practice in the selection and use of cupola refractories, there is still room for much more careful inquiry into true cost and much greater consideration of the inherent properties of lining and patching materials as affecting the manner in which they are used and the conditions to which they are exposed. On both of these lines it would be possible in most iron foundries to effect considerable economies.

XUM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Trade Talk.

At the weekly meeting of the Glasgow Dean of Guild Court a lining was granted to Messrs. Wilson Bros. to erect a machine shop at their new foundry, 100, Fordneuk Street, Bridgeton, Glasgow.

The North British Locomotive Company, Limited, Springburn, Glasgow, have received an order from the L. & N.E.R. for 24 locomotive boilers, for delivery at Stratford and Darlington.

Messrs. Thomas E. Gray & Company, Limited, 119, High Holborn, London, W.C.1, report that a well-known Lancashire firm have purchased a second large Zimmermann moulding machine from them, making a total of 20 machines sold since November 1.

In a progress report, the directors of Messrs. Darwins, Limited, Fitzwilliam Works, Sheffield, state that the accounts for the six months ended September 30 last show a net profit of £41,991. The orders in hand substantially exceed those for the corresponding period of last year, and the future outlook is good.

Messrs. Charles Connell & Company, Limited, Scotstoun, have launched the steel-screw steamer "Lammer Law," of 5,000 tons, which they have built for Messrs. Thomas Law & Company, Limited, Glasgow. The engines and machinery are being supplied by Messrs. David Rowan & Company, Limited, Glasgow.

Compression ignition engines as applied to aero work, and the dependability of the Diesel system, were discussed by members of the Institution of Automobile Engineers and the Derby Society of Engineers at Derby Technical College on November 19, when a Paper on the subject was presented by Mr. H. V. Taylor, of Coventry.

The Clyde members of the United Patternmakers' Society employed in shipbuilding and engineering establishments asked for an advance of 4½d. per hour on their present rate of 1s. 4½d. This has been refused by the employers on three separate occasions, and as a protest against the refusal the Society has imposed an embargo on overtime.

A giant mystery locomotive which recently left a Glasgow works has arrived at Darlington, where it will be completed in L. & N.E.R. shops. It is rumoured that this engine, the building of which is proceeding under conditions of strict secrecy, will have a speed of 100 miles an hour. It is said that the smoke stack will be finished off flush with the surface of the boiler.

An inquiry into the methods of regulating wages is being conducted by the General Council of the Scottish Trades Union Congress. A report has been prepared regarding the methods of regulating wages in Australia, South Africa, Canada, Germany and Denmark. Particular attention has to be paid in the report to those workers whose wages are not regulated by collective bargaining between employers and employed.

Following Mr. J. H. Thomas's suggestion that a large-scale use should be made of steel sleepers on railways in the United Kingdom and abroad, the Tees-side Bridge & Engineering Works, Limited, Middlesbrough, state that for three months they have been manufacturing steel sleepers under contract for the London & North Eastern Railway. The sleepers are of a patent design. The rolling of the steel, for which rolls of a special pattern have been cut, is being undertaken by the Cargo Fleet Iron Company, Limited.

As a result of the successful performances of the Yarrow land boilers installed a few years ago at the Royal Dockyard, Devonport, boiler-house extensions, Messrs. Yarrow & Company, Limited, Scotstoun, have secured an order for a fifth unit, comprising, as before, Yarrow patent boiler, integral superheater, mechanical forced-draft stoker and cast-iron economiser superposed in series. The latest boiler installation at Portsmouth Dockyard, comprising six Yarrow patent water-tube boilers, are also giving highly satisfactory service.

Through the generosity of Messrs. Dobbie, Forbes & Company, Limited, ironfounders, Larbert, the Parish Council have been able to supply a long-felt want of a playing field for the village children. The opening ceremony took place in the presence of a representative company of the public authorities on November 9, when Mr. George Dobbie, on behalf of the firm, formally handed to the chairman of the Council the deed of gift. Messrs. Jones & Campbell, Torwood Foundry, Larbert, at the same time presented a number of seats for the field.

Interest has been evinced in the fact that the meetings of the shareholders of Messrs. Bolckow, Vaughan & Company, Limited, the Tees-side iron and steel concern, should be held in Manchester. It is explained that this is to meet the convenience of shareholders, the majority of whom reside in Manchester. The works were established at Middlesbrough in 1840, but it was a committee of Manchester business and commercial men who formed the limited liability company in November, 1864, which took over the concern on January 1 of the following year.

The importance of a knowledge of metallurgy to the engineer was stressed by Mr. R. A. Montgomery, of Sheffield, when he addressed the Glasgow and West of Scotland Association of Foreman Engineers and Draughtsmen in Glasgow on November 9. The engineer and the metallurgist, said Mr. Montgomery, should work together, and the engineer should have some knowledge of metallurgy. Equipped with that knowledge, he could discuss the matter intelligently with his metallurgist, and so arrive at the most suitable material to resist the stresses which it would have to bear in the particular job contemplated.

Mr. A. K. Wilson, the Master Cutler, acknowledged with gratitude, at the banquet of the Ironmongers' Company recently, the Company's grant for seven years of £800 to provide a Fellowship and two scholarships at Sheffield University for research work on cold-rolled steel. The necessary plant and appliances for the research had been given by Sheffield manufacturers, while the buildings, furnace and laboratory had been found by Sheffield University, said Mr. Wilson. The plant was now installed and ready for working. Cold-rolled steel was a branch of metallurgy which had developed enormously in the last fifteen years.

It was recently announced that the Underfeed Stoker Company, Limited, had secured rights to manufacture Vibro conveyors under the Schenck-Heymann system at their Derby works. We are informed that the company have already secured an order for six Schenck-Heymann Vibro conveyors from Imperial Chemical Industries, Limited. The conveyors are of special design and are capable of handling fine cement dust at a temperature of approximately 400 deg. C., with capacities up to 30 tons per hr. A further conveyor of this type has been ordered for use as a combined conveyor and screen, its capacity being 100 tons of limestone per hour.

The number of unemployed members of the Amalgamated Engineering Union in Scotland remained stationary during October. The average weekly number was 463, compared with 457 in October last year in the Glasgow area. There has been an increase in the number of unemployed in Paisley, which was counterbalanced by a decided decrease in the Renfrew district. At Greenock and Dumbarton, trade is still very good, but Kilmarnock and Lanark show no improvement. Delegate reports that there has been no change in Edinburgh, and that on present showing the outlook for the winter is anything but encouraging. In Dundee employment is good in shipbuilding and marine engineering, but in the textile department short-time working persists.

On November 28 the British Electrical and Allied Manufacturers' Association will publish an important survey of the economic position and organisation of the British electrical industry. It represents the work of almost two years' continuous economic research into the main factors governing the growth of the industry and the development of its present predominance in export markets. It discusses in detail the modernisation of equipment in the basic industries, and shows how, through electrification, a new period of economic prosperity should take place in this country. The monograph also contains proposals advanced on behalf of the electrical industry for the expansion of production at home and the strengthening of the competitive position abroad.

Much disquiet is being felt in Scottish shipbuilding Trade Union circles concerning the relationships between the joiners' section of the Woodworkers' Society and the Employers' Federation. An official of a union likely to be seriously affected if the lock-out is not averted stated that "anyone who imagines that the employers are bluffing is living in a fool's paradise. The employers, so far as I can see, have no option but to carry out their threat. They have exhausted all the processes known to conciliation methods, but the inability of the Woodworkers' executive to discipline its members has thwarted them. There is need for courageous leadership if our union, which is bound to be affected, is not to be badly hit. There is, I understand, a likelihood of the unions calling a meeting in the near future to consider their position in the event of a lock-out becoming operative. The suggestion that the General Council's attention should be directed to the grave issues involved is piquant."

Contracts Open.

Aliwal North, S.A., December 3.—140,500 ft. of galvanised screwed and socketed piping, etc., for the Municipality of Aliwal North. The Department of Overseas Trade. (Reference A.X. 8,777.)

Melbourne, December 16.—Pumping plant, with ironwork, crane and gantries, for the Department of Public Works of New South Wales. The Department of Overseas Trade. (Reference A.X. 8,740.)

Newbury, December 5.—Pumping machinery, etc., for the Corporation. H. Humphreys & Sons, 28, Victoria Street, Westminster. (Fee £3 3s., returnable.)

Pretoria, December 27.—Telegraph material, for the Department of Posts and Telegraphs. The Department of Overseas Trade. (Reference A.X. 8,734.)

South Africa, December 4.—200 cast-iron pole bases, for the City of Cape Town Electricity Department. The Department of Overseas Trade. (Reference A.X. 8,771.)

South Africa, December 4.—50 35-ft. and 1,500 30 ft. tubular poles, for the City of Cape Town Electricity Department. The Department of Overseas Trade. (Reference A.X. 8,773.)

Company News.

Thos. Vickers, Limited, 14, New Street, Birmingham.—Capital £300. Iron and steel merchants, etc. Directors: T. Vickers and C. O. H. Ward.

Holt Chromium Plating Company, Limited.—Capital £1,000. Directors: M. J. Sandbrook and F. W. Bell, 110, Havelock Road, Saltley, Birmingham.

Beaumont Foundry, Limited.—Capital £3,500. Directors: A. M. Wilson, 5, Sulivan Road, Hurlingham, London, S.W.; F. Thompson and J. F. Burrell.

Thomas R. Whatcott & Son, Limited, 56, Nevill Road, Stoke Newington, London, N.—Capital £5,000. Scrap metal merchants, etc. Directors: T. R. Whatcott and A. E. Whatcott.

Bassett, Bagnall & Company, Limited, 3, James Street, St. Pauls, Birmingham.—Capital £20,000 in £1 shares. Metal manufacturers, etc. Directors: J. B. and P. W. B. Blakemore.

Obituary.

Mr. S. Barton, a well-known brassfounder, died at his home, North Leys, last week, at the age of 80.

Sir Robert Balfour, formerly chairman of Metal Traders, Limited, London, died on November 4, aged 85 years.

The death occurred recently, at Rothesay, of ex-Bailie James Hamilton Bell, J.P., engineer and ironfounder, Wishaw.

Mr. Charles Burrell, of Messrs. Charles Burrell & Sons, Limited, engineers and ironfounders, of Thetford, died on November 12 at the age of 82.

Mr. Percy D. Hale, for many years manager of Messrs. Stableford & Company, Limited, engineers and wagon builders, Coalville, died recently, aged 45 years.

Personal.

Mr. George Albert Ure, managing director of Messrs. Smith & Wellstood, Limited, Bonnybridge, has been nominated for re-election to the County Council, Stirlingshire Eastern District.

Mr. H. S. Clark, of J. H. Clark & Company, ironfounders, of South Tottenham, has removed from 17, Filey Avenue, Stoke Newington, London, N.16, to 10, Creighton Avenue, Muswell Hill, N.10.

Mr. T. McFarlane, after 32 years as foundry foreman of the Horsehay Company, Limited, has resigned his position, and is now living in retirement in Scotland. Mr. McFarlane was one of the original members of the British Foundrymen's Association, and has been a familiar figure at the annual conferences, only having missed one of the meetings since its inception.

Will.

Whiston, T., Clay Cross, foundry manager £2,961

Dickson, J., Sheffield, chairman of Henry Rossel & Company, Limited, steel manufacturers, of Sheffield £5,206

Bottomley, F. B., managing director of Messrs. B. M. Renton & Company, Limited, steel manufacturers, Sheffield £19,699

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Something *really* new in
CUPOLA LININGS

After many years of careful study of technical literature and the advertisements of our contemporaries, we have been driven to the conclusion that there are

TWO WEAK FACTORS IN ORDINARY BRICK LININGS
(1) THE JOINTS (2) THE BRICKS

We have destroyed the first bogey for ever by the introduction of "PYROLYTE" Fire Cement which sets cold harder than the bricks, and makes joints that after weeks of severe use of the cupola stand out beyond the brickwork because of their greater strength and infusibility.

[Sample cwt. in free steel drum 30/- delivered]

For some time now, we have been trying to solve the second problem by the production of a

"PYROLYTE BRICK"

which will possess the remarkable virtues of the fire cement combined with those additional qualities needed in a brick—We *think* we have succeeded but—

WE NOW NEED THE HELP OF HALF-A-DOZEN FOUNDRYMEN WHO WILL TRY OUT A RING OR TWO OF THE SAMPLE BRICKS WE WILL MAKE TO THEIR SIZE AND DELIVER TO THEM FREE IF THEY WILL KINDLY WRITE US WITH PARTICULARS.

Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—Although at present the demand for Cleveland iron is on a comparatively limited scale, it is quite sufficient to absorb current outputs at local furnaces, now operating on a reduced scale, one or two of the principal makers of foundry pig having closed down a portion of their plants. This movement on the part of the ironmasters will mean that the production of pig-iron will henceforth be barely equal to the needs of the industry and should relieve them of all anxiety regarding the disposal of their iron. Very little Cleveland iron is being sold for export, but the home demand is sufficient to absorb the available supplies, and ironmasters report that they have sold a good deal more than they have in stock. Consequently Cleveland ironmasters are content to adhere to the fixed minima, and, although small concessions may be obtained on purchases made through merchants, these are subject to many limitations, and the ruling prices for the bulk of the turnover are steady at the following figures:—No. 1 Cleveland foundry iron, 75s.; No. 3 Cleveland G.M.B., 72s. 6d.; No. 4 foundry iron, 71s. 6d.; No. 4 forge iron, 71s. per ton.

Following the example of the makers of foundry pig on Tees-side, there has been a reduction in the output of East Coast hematite, and this synchronises with a good deal of activity in the market. The makers are well sold to the end of the year, both to home consumers and for export, and they have also arranged a number of contracts over the first quarter of next year. The position has, in fact, been so strengthened that 78s. per ton has become a firm quotation for November and December deliveries, and beyond that date 80s. per ton is asked, as no hope is held out of any fall in works costs. On the North-West Coast Bessemer mixed numbers are quoted at 77s. per ton at works.

LANCASHIRE.—In the local markets for foundry iron, now that prices have been stabilised at current rates until the New Year, consumers are buying mostly for immediate needs, and forward business is very quiet. Meanwhile the ironfounders, generally speaking, are busy. This fact is obvious from the amount of iron going into consumption, which continues to be at a very good rate. Quotations are as follow:—For delivery to local consumers' works Derbyshire and Staffordshire makes are both on offer at 77s. per ton. Scottish brands are still quoted for delivery at about 92s. 6d. to 93s. 6d. per ton.

THE MIDLANDS.—As usual at this period of the year, buying in the local markets for foundry pig is mostly confined to limited quantities to meet immediate needs, with few transactions on forward account recorded. Meanwhile the minimum zone figures are being quoted generally, and they are 75s. for Northants No. 3, 78s. 6d. for Derbyshire No. 3, and 79s. 6d. for North Staffs No. 3, delivered local stations.

SCOTLAND.—In the markets for Scotch pig-iron the demand is meagre, but with the limited output there is no large accumulation of stocks, as makers generally are trying to measure their production with the demand. The price of foundry iron is unchanged on the basis of 76s. per ton f.o.t. furnaces, with a minimum of 2s. 6d. per ton extra for No. 1.

Finished Iron.

In the manufacturing branches the position with regard to crown and the cheaper grades of iron does not alter in any way. Orders of any note are not forthcoming either from consumers or stockholders in the Black Country area. Prices are firmer, crown iron being at £10 to £10 10s. from local works, although lower prices prevail from outside districts. Nut and bolt-iron is at £9 to £9 5s., but little support is possible in this direction owing to the continued presence of very keen competition from the Continental works. Staffordshire marked bars are at £12 10s. at works, and the mills making this class of iron continue to be occupied at a good rate.

Steel.

At Sheffield the steel market is quiet, and not much business is being put through at the moment. The recent improvement in acid billet demands is barely maintained, and basic billet makers are feeling the competition developing from the Continent. There is a good level of business in wire rods, but to meet the competition of imported rods soft qualities have been reduced by about 7s. 6d. Current prices are:—Basic billets, soft, £7; semi-hard, £7 12s. 6d.; medium, £8 2s. 6d.; hard, £9 2s. 6d. to £9 12s. 6d.; Siemens acid, £9 10s.; wire rods, soft, £8 2s. 6d.; medium, £9 15s. to £10; hard, £10 10s. to £11; acid, £12 5s. to £12 10s.; steel hoops, £9 15s. to £10. In the tinplate market current quotations rule as follow:—Coke tinplates, 18s. 9d. to 18s. 10½d. basis, net cash, f.o.b. Welsh ports.

Scrap.

Very little change can be reported in the position of scrap markets in general, and in Scotland the foundries are buying sparingly, but still have to pay 66s. per ton for ordinary cast iron, and good machinery quality in handy sizes commands 68s. 6d. per ton. Light cast-iron scrap is at 60s., with cast-iron firebars at 57s. 6d. The above prices are all per ton delivered f.o.t. consumers' works. In Yorkshire heavy cast-iron scrap is maintained at 65s. for ordinary and 67s. for machinery quality. On the North-East Coast cast iron is still very plentiful, as foundry requirements are limited, even at 70s. for first-quality machinery cast iron in pieces not exceeding 1 cwt., and 65s. for ordinary cast iron to the same specification.

Metals.

Copper.—Values of warrant copper, though continuing weak, have not receded to any serious extent since last reported, and this week there has been a slight recovery from the worst. In spite of the low prices now ruling, the demand does not seem to have been stimulated to any extent, and the demand for still cheaper copper continues.

Closing quotations are:—

Cash.—Thursday, £68 to £68 2s. 6d.; Friday, £68 17s. 6d. to £69; Monday, £69 5s. to £69 10s.; Tuesday, £70 to £70 2s. 6d.; Wednesday, £69 10s. to £69 12s. 6d.

Three Months.—Thursday, £67 12s. 6d. to £67 15s.; Friday, £68 16s. 3d. to £68 18s. 9d.; Monday, £69 5s. to £69 7s. 6d.; Tuesday, £69 2s. 6d. to £69 5s.; Wednesday, £69 to £69 2s. 6d.

Tin.—Following the recent depression which brought standard tin values to the lowest point reached since 1922, there has been a sharp recovery in quotations, American buying, aided by a jump of £5 in the Eastern price and talk of a plan for restricting mine operations, resulting in quotations being rushed up to £180 5s. for cash and £183 5s. for forward delivery. The recovery was not wholly maintained.

Official closing prices:—

Cash.—Thursday, £177 17s. 6d. to £178; Friday, £180 5s. to £180 10s.; Monday, £180 5s. to £180 10s.; Tuesday, £179 7s. 6d. to £179 12s. 6d.; Wednesday, £179 12s. 6d. to £179 17s. 6d.

Three Months.—Thursday, £180 17s. 6d. to £181; Friday, £183 2s. 6d. to £183 5s.; Monday, £183 5s. to £183 10s.; Tuesday, £182 to £182 5s.; Wednesday, £182 10s. to £182 15s.

Spelter.—The weakness of the spelter market has been further accentuated during the past week. Messrs. Lewis Lazarus & Sons report a further depressing factor in an increase during October of 3,750 tons in the American stocks. It remains to be seen what steps will be taken by the Cartel at their meeting this week.

Daily quotations are:—

Ordinary.—Thursday, £21 5s.; Friday, £22; Monday, £21 16s. 3d.; Tuesday, £21 13s. 9d.; Wednesday, £20 13s. 9d.

Lead.—The continued weakness in this market is ascribed to the fact that although the world's production of lead is expanding slowly, there is no doubt that simultaneously there is a restriction in the world's requirements. Shipments of Burma lead to this country in important quantities show that this metal cannot find its usual outlet on the Continent, and the prospects are that arrivals in the near future will exceed requirements.

The week's prices have been:—

Soft Foreign (Prompt).—Thursday, £21 17s. 6d.; Friday, £22; Monday, £21 17s. 6d.; Tuesday, £21 17s. 6d.; Wednesday, £21 7s. 6d.

Correspondence.

Professor Piwowarsky's Book.

To the Editor of The Foundry Trade Journal.

Sir,—With reference to the interesting review, published in your issue of November 7, of Professor Piwowarsky's new book on "High Duty Cast Iron," I should be glad if you would permit me to point out that the references made in the book to the work of the Association cannot be to Research Reports, as these are confidential to members. The score or so such references in the book, in fact, concern either matter in our quarterly Bulletin or Papers given by the staff of the Association to technical and scientific institutions, which are frequently issued in the first place as Research Reports. This applies equally to such references made elsewhere.—Yours, etc.,

J. G. Pearce, Director.

The British Cast Iron Research Association,
Registered Offices and Laboratories,
24, St. Paul's Square, Birmingham.

November 18, 1929.

The Next Imperial Conference.

Preparatory Committee Formed.

In view of the forthcoming Imperial Conference in 1930, an arrangement has been come to between the Association of British Chambers of Commerce, the Federation of British Industries and the Chamber of Shipping of the United Kingdom, representing the commercial, industrial and shipping interests of this country, to form a British Preparatory Committee to consider the general question of Empire Commercial Policy, with the object of co-ordinating as far as possible the views of the business community of the United Kingdom and of presenting to His Majesty's Government joint recommendations on all questions upon which unanimity of opinion can be obtained. Each of the organisations represented has appointed its own Preparatory Committee, whose preliminary conclusions will be communicated to the British Preparatory Committee for joint consideration.

The members of the Committee so far nominated include the representatives of:—

The Association of British Chambers of Commerce: Sir Gilbert Vyle, Ex-President; Sir Edward Iliffe, C.B.E., Vice-President; Sir Francis Joseph, C.B.E., President of the North Staffordshire Chamber of Commerce, and Mr. R. B. Dunwoody, C.B.E., Secretary.

The Federation of British Industries: Sir Arthur Duckham, G.B.E., Chairman F.B.I. Preparatory Committee; Sir Roland Nugent, Director; Mr. Guy Locock, C.M.G., Deputy-Director, and Mr. Moir Mackenzie, Empire Department.

The Chamber of Shipping of the United Kingdom: Sir William Currie, President; Sir Alan Anderson, K.B.E., ex-President.

Informal meetings of the Committee have already taken place and the first formal meeting will be held shortly, when the personnel will be completed and a programme for the Committee's work laid down.

A German Exchange.

The head of a large foundry in Saxony making all kinds of non-ferrous castings, and having its own machine shops, desires to make an arrangement with a British Founder whereby his son, a young man of 24 years of age, could enter a British works on the buying or selling staff for a period of some six months in order to learn the language. In return for this, the gentleman in question would be prepared to extend similar hospitality to a young Englishman. Anyone interested can obtain further details on communicating with the Editor.

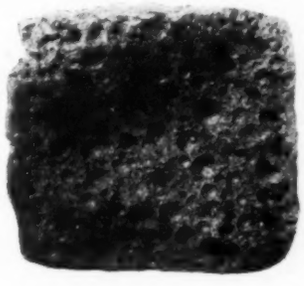
Bradley's Bradley's Bradley's Bradley's Bradley's Bradley's Bradley's Bradley's Bradley's Bradley's Bradley's Bradley's

Introducing- A NEW "SERVICE" DEVELOPMENT

Bradley's Degasified Refined Irons

"For Flawless Foundrywork"

REALISING the great number of cases in which dissolved gases are at least a contributory cause of unsoundness in castings, The Bradley Research Laboratories after considerable experiment have at last devised a process for the production of pig-iron with a reduced gas content. In so doing, Bradley's are following upon developments in other sections of the foundry industry and maintaining their reputation for Service. The special plant and equipment for carrying out Bradley's Degasified process is now in operation, and the well-known brands of Bradley's Refined Irons can now be had as Degasified Irons.



The illustration, from an unretouched photograph, shows a typical case of unsoundness due to "wild" metal.

Another case of unsoundness showing pinholes in a Centrifugal casting due to entrapped gases.

This illustration shows the pinholes on the surface of the Centrifugal casting shown above.

"For Flawless Foundrywork"

Unsoundness in castings arises from a good many causes, operating either singly or conjointly. Investigation is able to trace unsoundness to the mould gases and air entrapped in the solidifying metal. The methods of moulding, coremaking, the disposition of the runners and gates, the composition of the metal, the metal temperature and the conditions of melting in the Cupola are some of the aspects which have to be considered in tracing the cause of unsoundness. A very important cause of unsoundness is the dissolved or occluded gases which exist in the iron. The unsoundness defect arising from dissolved gases is usually of a most troublesome character, as it is generally found in those important castings which are required to machine all over and to withstand internal pressure tests.

The foundryman may have taken all possible precautions against unsoundness, in spite of which these defects, due to dissolved gases, make their appearance, generally slight, but sufficient to scrap important castings. With the object of still further reducing the possibility of waster castings from these last traces of unsoundness The Bradley Research Laboratories have devised a process of producing Refined Pig-Iron with a reduced gas content. To enable the principles of the Degasification process to be carried out, plant has been adapted to allow the refined iron, whilst molten, to be subjected to violent agitation under carefully controlled temperature conditions. The refined iron treated by this process is freed from dissolved gases and suspended slag, and the treatment ensures a uniformity of composition in the superlative degree. The freedom from dissolved gases and suspended slag in Bradley's Degasified Refined Irons is accompanied by a greater "life" and castability.

ENQUIRIES INVITED . .

We shall be glad to receive enquiries from all foundrymen interested in our Degasified Refined Irons. Our Technical Staff is always at your service on all problems appertaining to the selection of Foundry Pig-Iron for specific purposes. This is part of the "Bradley Service."

BRADLEY & FOSTER LIMITED, DARLASTON BLAST FURNACES, DARLASTON.

Telephone: DARLASTON 16 (Private Branch Exch.).

Telegrams: "BRADLEY, DARLASTON."

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WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	69	10	0
Three months	69	0	0
Electrolytic	81	10	0
Tough	74	10	0
Best selected	75	0	0
Sheets	110	0	0
India	91	0	0
Wire bars	83	5	0
Do. Dec.	83	5	0
Do. Jan.	83	5	0
Ingot bars	83	5	0
H.C. wire rods	85	5	0
Off. av. cash, October	72	17	$2\frac{17}{25}$
Do., 3 mths., October	73	4	$1\frac{21}{48}$
Do., Sttlmnt., October	72	17	6
Do., Electro, October	84	5	$2\frac{1}{21}$
Do., B.S., October	77	15	10
Do., wire bars, October	84	10	$10\frac{10}{21}$
Aver.spot price,copper,Oct.	72	17	$2\frac{17}{25}$
Solid drawn tubes			15d.
Brazed tubes			15d.
Wire			$11\frac{1}{2}$d.

BRASS.

Solid drawn tubes	$12\frac{1}{2}$d.
Brazed tubes	$14\frac{1}{2}$d.
Rods, drawn	$12\frac{1}{2}$d.
Rods, extd. or rlld.	8d.
Sheets to 10 w.g.	$11\frac{1}{2}$d.
Wire	$10\frac{1}{2}$d.
Rolled metal	$10\frac{1}{2}$d.
Yellow metal rods	8d.
Do. 4 × 4 Squares	$8\frac{1}{2}$d.
Do. 4 × 3 Sheets	9d.

TIN.

	£	s.	d.
Standard cash	179	12	6
Three months	182	10	0
English	180	10	0
Bars	181	15	0
Straits	183	7	6
Australian	181	7	6
Eastern	185	2	6
Banca	190	7	6
Off. av. cash, October	190	17	$7\frac{7}{23}$
Do., 3 mths, October	194	17	$3\frac{9}{23}$
Do., Sttlmt., October	190	17	$7\frac{7}{23}$
Aver. spot, October	190	17	$7\frac{7}{23}$

SPELTER.

	£	s.	d.
Ordinary	20	13	9
Remelted	20	0	0
Hard	18	0	0
Electro 99.9	24	0	0
English	22	2	6
India	19	10	0
Zinc dust (Nom.)	32	0	0
Zinc ashes	7	0	0
Off. aver., October	23	2	$6\frac{15}{23}$
Aver., spot, October	22	18	$6\frac{9}{23}$

LEAD.

	£	s.	d.
Soft foreign ppt.	21	7	6
English	22	15	0
Off. average, October	23	4	$9\frac{9}{23}$
Average spot, October	23	4	$6\frac{15}{23}$

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	30	10	0
Do. V.M. ex-whf.	29	10	0
Rods	34	0	0
Boiler plates	27	0	0
Battery plates	27	10	0

ANTIMONY.

	£	s.	d.
Special brands, Eng.	48	15	0
Chinese	31	0	0
Crude	20	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	22	17	6

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£	s.	d.
Ferro-silicon—			
25%	7	17	6
45/50%	11	10	0
75%	19	0	0
Ferro-vanadium—			
35/50%	12/10 lb. Va.		
Ferro-molybdenum—			
70/75% c. free	4/2 lb. Mo.		
Ferro-titanium—			
23/25% carbonless	1/2 lb.		
Ferro-phosphorus, 20/25%	£16	0	0
Ferro-tungsten—			
80/85%, c. fr.	$3/3\frac{1}{2}$ lb.		
Tungsten metal powder—			
98/99%	$3/6\frac{1}{2}$ lb.		
Ferro-chrome—			
2/4% car.	£30	10	0
4/6% car.	£23	2	6
6/8% car.	£22	0	0
8/10% car.	£21	15	0
Ferro-chrome—			
Max. 2% car.	£33	5	0
Max. 1% car.	£38	0	0
Max. 0.70% car.	£39	15	0
70% carbonless	1/- lb.		
Nickel—99% cubes, or pellets	£175	0	0
Ferro-cobalt	9/6 lb.		
Aluminium 98/99%	£95	0	0
Metallic chromium—			
96/98%	2/7 lb.		
Ferro-manganese (net)—			
76/80% loose	£13	10	0
76/80% packed	£14	10	0
76/80%, export	£14	0	0
Metallic manganese—			
94/96%, carbonless	1/6 lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	£	s.	d.
Finished bars, 14% tungsten	£0	2	0
Finished bars, 18% tungsten	£0	2	9

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under $\frac{1}{2}$ in. to $\frac{1}{4}$ in.	3d. lb.
Do., under $\frac{1}{4}$ in. to $\frac{3}{16}$ in.	1/- lb.
Flats, $\frac{1}{2}$ in. × $\frac{1}{4}$ in. to under 1 in. × $\frac{1}{4}$ in.	3d. lb.
Do., under $\frac{1}{2}$ in. × $\frac{1}{4}$ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£	s.	d.		£	s.	d.
South Wales—							
Heavy steel	3	10	0	to	3	12	6
Bundled steel and shrngs.	3	7	6	to	3	10	0
Mixed iron and steel	3	5	0	to	3	7	6
Heavy cast iron	3	0	0	to	3	1	6
Good machinery for foundries	3	2	6	to	3	5	0
Cleveland—							
Heavy steel					3	5	0
Steel turnings					2	17	6
Cast-iron borings					2	13	6
Heavy forge					3	15	0
W.I. piling scrap					3	10	0
Cast-iron scrap	3	6	0	to	3	8	6
Lancashire—							
Cast-iron scrap	3	2	6	to	3	10	0
Heavy wrought					4	0	0
Steel turnings					2	17	6
Scotland—							
Heavy steel					3	12	6
Cast-iron borings					2	15	0
Wrought-iron piling					3	18	0
Heavy machinery					3	10	0

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	62	0	0
Brass	43	0	0
Lead (less usual draft)	19	0	0
Tea lead	16	10	0
Zinc	14	10	0
New aluminium cuttings	68	0	0
Braziery copper	57	0	0
Gunmetal	57	0	0
Hollow pewter	140	0	0
Shaped black pewter	100	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	75/-
Foundry No. 3	72/6
Foundry No. 4	71/6
Forge No. 4	71/-
Hematite No. 1	78/6
Hematite M/Nos.	78/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	86/-
,, d/d Birm.	93/6
Midlands—	
Staffs. common*	—
,, No. 4 forge*	75/6
,, No. 3 fdry.*	79/6
Shrops. basic	—
,, Cold blast, ord.	—
,, ,, roll iron	—
Northants forge*	71/-
,, fdry. No. 3*	75/-
Derbyshire forge*	74/6
,, fdry. No. 3*	78/6
,, basic*	—

*d/d Black Country dist.

Scotland—	
Foundry No. 1	78/6
,, No. 3	76/-
Hem. M/Nos.	80/-
Sheffield (d/d district)—	
Derby forge	69/9
,, fdry. No. 3	73/6
Lincs. forge.	72/6
,, fdry No. 3	76/6
E.C. hematite	87/6
W.C. hematite	89/6
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3	77/-
Northants foundry No. 3	—
Dalzell, No. 3 (special)	105/- to 107/6
Summerlee, No. 3	93/-
Glengarnock, No. 3	—
Gartsherrie, No. 3	93/-
Monkland, No. 3	93/-
Shotts, No. 3	93/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron ; delivered consumers' station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.) nom.				10	15	0
Nut and bolt iron	9	0	0 to	9	5	0
Hoops				11	0	0
Marked bars (Staffs) f.o.t.				12	10	0
Gas strip				11	0	0
Bolts and nuts, $\frac{3}{4}$ in. × 4 in.				15	5	0
Steel—						
Ship plates	8	12	6 to	8	17	6
Boiler plts.	9	12	6 to	10	10	0
Chequer plts.				10	12	6
Angles				8	2	6
Tees				9	2	6
Joists				8	2	6
Rounds and squares, 3 in. to $5\frac{1}{2}$ in.				9	2	6
Rounds under 3 in. to $\frac{3}{8}$ in. (Untested)				8	2	6

and upwards

	£	s.	d.		£	s.	d.
Flats—8 in. wide and over					8	7	6
,, under 8 in. and over 5 in.					8	12	6
Rails, heavy					8	10	0
Fishplates					12	10	0
Hoops (Staffs)					9	15	0
Black sheets, 24 g.					10	5	0
Galv.cor.shts., 24g.	12	15	0	to	13	2	6
Galv. fencing wire 8g. plain					12	0	0
Billets, soft	6	5	0	to	6	15	0
Billets, hard	7	10	0	to	8	0	0
Sheet bars					6	5	0
Tin bars					6	5	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1/4
Sheet to 10 w.g.	1/5
Wire	1/6
Rods	1/5
Tubes	$1/9\frac{1}{2}$
Castings	1/4

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	10d. to 1/4
Rolled—	
To 9 in. wide	1/4 to 1/10
To 12 in. wide	$1/4\frac{1}{4}$ to $1/10\frac{1}{4}$
To 15 in. wide	$1/4\frac{1}{2}$ to $1/10\frac{1}{2}$
To 18 in. wide	1/5 to 1/11
To 21 in. wide	$1/5\frac{1}{2}$ to $1/11\frac{1}{2}$
To 25 in. wide	1/6 to 2/-
Ingots for spoons and forks	10d. to $1/6\frac{1}{2}$
Ingots rolled to spoon size	1/1 to $1/9\frac{1}{2}$
Wire round—	
3/0 to 10 G.	$1/7\frac{1}{2}$ to $2/2\frac{1}{2}$

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	21.26
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	14.50
Basic	20.26
Bessemer	20.76
Malleable	20.76
Grey forge	19.76
Ferro-mang. 80% d/d	105.00
O.-h. rails, h'y at mill	43.00
Bessemer billets	35.00
O.-h. billets	35.00
O.-h. sheet bars	35.00
Wire rods	40.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.90
Tank plates	1.90
Beams, etc.	1.90
Skelp, grooved steel	1.90
Skelp, sheared steel	1.90
Steel hoops	2.20
Sheets, black, No. 24	2.75
Sheets, galv., No. 24	3.50
Sheets, blue an'l'd, No. 13	2.35
Wire nails	2.40
Plain wire	2.40
Barbed wire, galv.	3.05
Tinplates, 100-lb. box	$5.35

COKE (at ovens).

Welsh foundry	32/6 to 35/-
,, furnace	27/6 to 32/6
Durham and Northumberland—	
,, foundry	22/6
,, furnace	21/-
Midlands, foundry	—
,, furnace	21/6 and up

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 box	18/9
,,	28×20 ,,	38/-
,,	20×10 ,,	27/6
,,	$18\frac{3}{4}$×14 ,,	19/6
C.W.	20×14 ,,	16/-
,,	28×20 ,,	34/-
,,	20×10 ,,	$22/7\frac{1}{2}$
,,	$18\frac{3}{4}$×14 ,,	16/-
Terneplates	28×20	33/6 per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

	£	s.	d.		£	s.	d.
Pig-iron	£6	0	0	to	£7	10	0
Bars, hammered, basis	£17	10	0	to	£18	10	0
Bars and nail-rods, rolled, basis	£15	15	0	to	£16	15	0
Blooms	£10	0	0	to	£12	0	0
Keg steel	£32	0	0	to	£33	0	0
Faggot steel	£20	0	0	to	£24	0	0
Bars and rods dead soft, steel	£11	0	0	to	£14	0	0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.

Over ½ in. up to 6 in.

	Tubes.	*Fittings.*
Gas	65%	47½%
Water	61½%	42½%
Steam	57½%	37½%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
Nov.	14	68	0	0	dec.	5/–
,,	15	68	17	6	inc.	17/6
,,	18	69	5	0	,,	7/6
,,	19	70	0	0	,,	15/–
,,	20	69	10	0	dec.	10/–

Electrolytic Copper.

		£	s.	d.		
Nov.	14	81	10	0	No	change
,,	15	81	10	0	,,	,,
,,	18	81	10	0	,,	,,
,,	19	81	10	0	,,	,,
,,	20	81	10	0	,,	,,

Standard Tin (cash).

		£	s.	d.		
Nov.	14	177	17	6	inc.	47/6
,,	15	180	5	0	,,	47/6
,,	18	180	5	0	No	change
,,	19	179	7	6	dec.	12/6
,,	20	179	12	6	inc.	5/–

Tin (English ingots).

		£	s.	d.		
Nov.	14	178	10	0	inc.	50/–
,,	15	181	0	0	,,	50/–
,,	18	180	10	0	dec.	10/–
,,	19	179	15	0	,,	15/–
,,	20	180	10	0	inc.	15/–

Zinc Sheets (English).

		£	s.	d.		
Nov.	14	30	0	0	No	change
,,	15	30	10	0	inc.	10/–
,,	18	30	10	0	No	change
,,	19	30	10	0	,,	,,
,,	20	30	10	0	,,	,,

Spelter (ordinary).

		£	s.	d.		
Nov.	14	21	5	0	inc.	11/3
,,	15	22	0	0	,,	15/–
,,	18	21	16	3	dec.	3/9
,,	19	21	13	9	,,	2/6
,,	20	20	13	9	,,	20/–

Lead (English).

		£	s.	d.		
Nov.	14	23	5	0	inc.	5/–
,,	15	23	5	0	No	change
,,	18	23	5	0	,,	,,
,,	19	23	5	0	,,	,,
,,	20	22	15	0	dec.	10/–

Exports of Iron Castings in October and the ten months 1929, compared with October and the ten months 1928.

——	October, 1928.	October, 1929.	Ten months, 1928.	Ten months, 1929.	October, 1928.	October, 1929.	Ten months, 1928.	Ten months, 1929.
BUILDERS' CASTINGS—	Tons.	Tons.	Tons.	Tons.	£	£	£	£
Stoves, grates, etc., cisterns, baths, etc., and cooking and washing boilers—								
To Argentine Republic	195	117	1,522	1,631	6,257	5,344	61,380	75,387
,, British South Africa	190	315	2,831	2,886	7,814	11,371	100,471	103,998
,, ,, India	79	160	1,178	1,376	3,259	7,267	51,213	54,609
,, Australia	35	80	524	622	2,499	5,348	36,326	36,133
,, New Zealand	174	132	1,551	1,175	10,170	7,480	80,860	72,201
,, Other Countries	614	1,075	7,599	8,546	30,403	49,266	355,741	392,507
Total	1,287	1,879	15,205	16,236	60,402	86,076	685,991	734,835
PIPES AND FITTINGS—CAST—								
To Argentine Republic	975	1,226	7,884	21,018	8,854	11,879	80,048	196,412
,, British South Africa	1,074	1,506	4,588	6,260	10,757	15,247	65,154	78,964
,, ,, India	309	167	6,681	3,540	5,523	2,986	90,295	49,145
,, Straits Settlements and Malay States	2,530	727	13,958	17,976	18,599	7,234	124,648	133,124
,, Ceylon	1,640	260	3,271	1,923	13,755	2,703	30,376	19,356
,, Australia	1,376	123	8,713	3,092	12,824	2,145	92,894	35,828
,, Other Countries	4,011	8,049	46,694	57,650	50,578	87,521	607,671	683,320
Total	11,915	12,058	91,789	111,459	120,890	129,715	1,091,086	1,196,149
HOLLOW-WARE—								
Cast, not Enamelled, and Cast, Tinned	474	445	3,817	3,987	18,406	14,945	144,963	141,590
,, Enamelled	86	108	652	802	8,406	9,207	62,838	71,519
CASTINGS, in the rough—								
Iron	164	136	1,370	1,288	6,445	4,818	43,802	46,809
Steel	128	173	583	1,130	3,719	5,682	24,783	44,873

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